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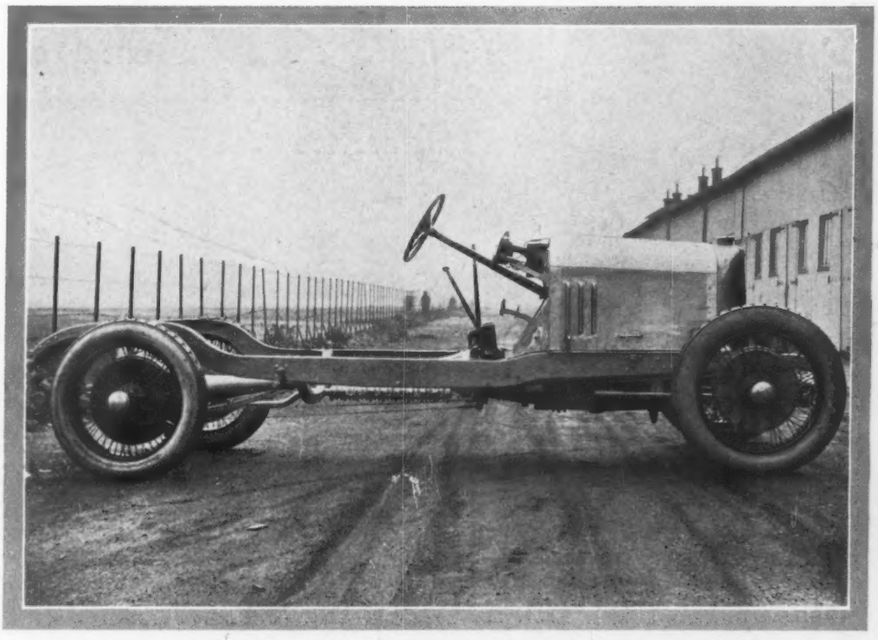

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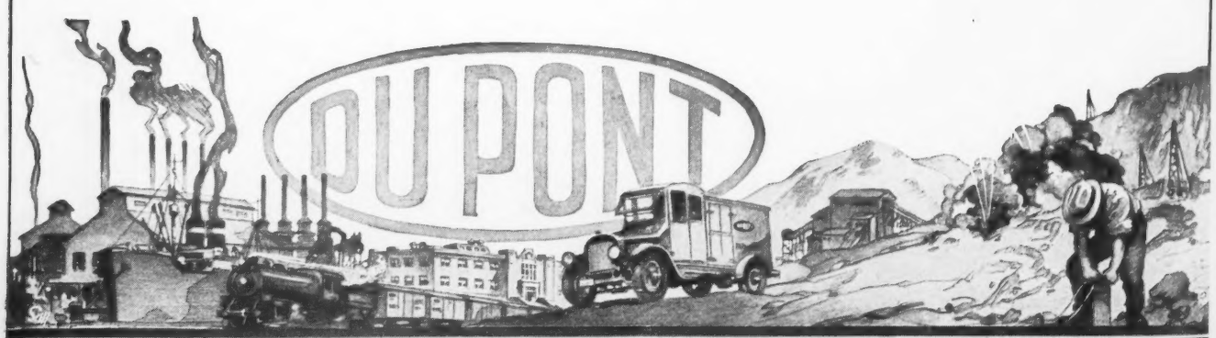

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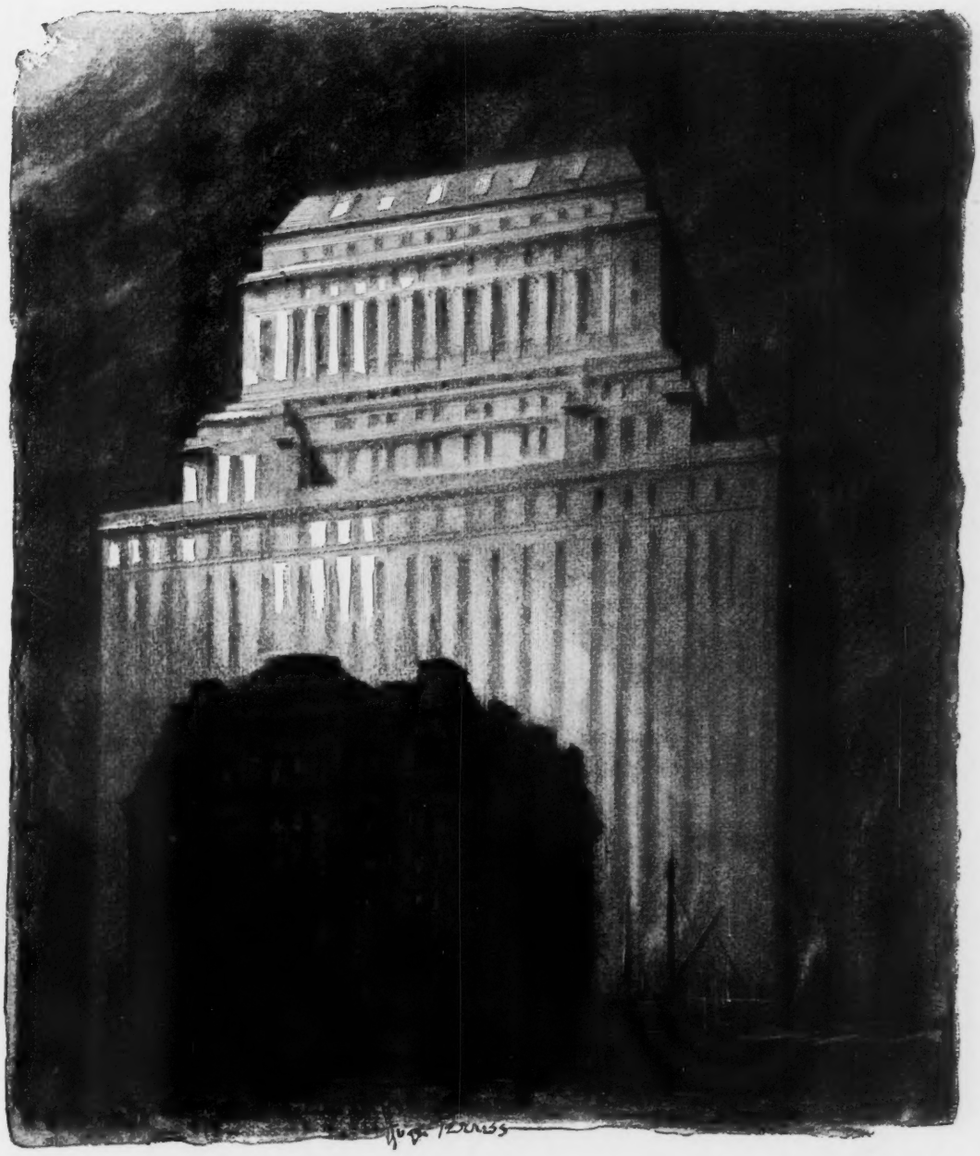

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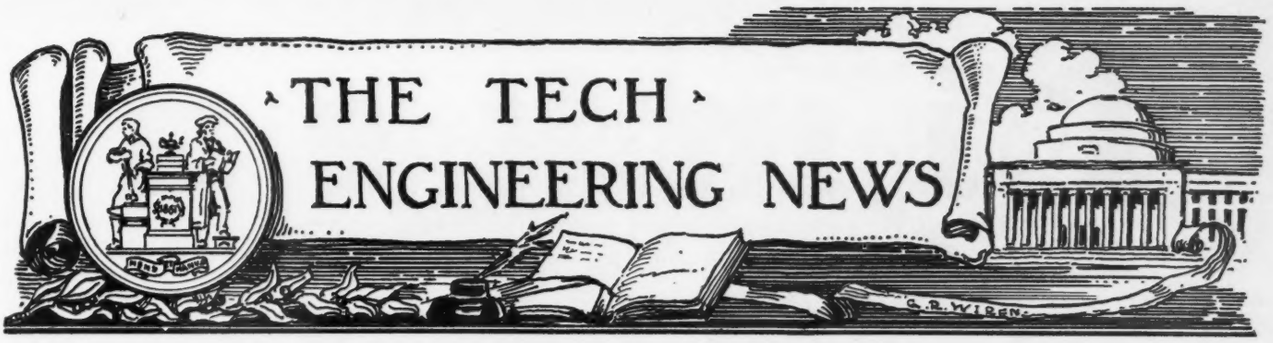

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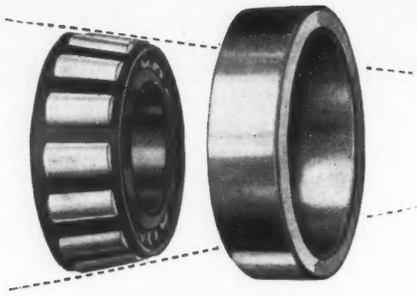

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THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE ALUMNI AND UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME IV DECEMBER, 1923 NUMBER 6

THE VAIL LIBRARY AT TECHNOLOGY

By RUTH M. LANE
Vail Librarian

WHEN Theodore Newton Vail was dealing with those first problems of life — reading, 'riting and 'rithmetic — at a little wooden schoolhouse in Morristown, N. J., George Edward Dering, over in Herts, England, was delving into the mysteries of electric telegraphy and exhibiting patents at the Great London Exhibition of 1851. The American and the Englishman never met, but their lives are linked in a great common endeavor and their names together are a source of inspiration to the students who follow the electrical engineering courses at the Massachusetts Institute of Technology.

George Edward Dering belonged to a well-known English family settled in Kent since the Conquest. His home was Lockleys — a beautiful old house in Welwyn, about twenty-five miles north of London on the Great North Road. His father, a typical country gentleman of the old-fashioned type, a keen sportsman and a first-rate farmer, had made of his home a model estate — the pride of the neighboring countryside. Young Dering attended Rugby, but refused to go to any university. From his Rugby tutor, Henry Highton, a prolific inventor of electric and telegraphic appliances, he had acquired the love for scientific research. He went to an institution which gave him the necessary training in science and engineering, and devoted himself to electrical experimenting. Mr. Dering patented a needle telegraph which was used in the Bank of England in 1851, and on the first Dover-Calais cable when it worked successfully between London and Paris during the busy days of the Crimean War. He also formulated proposals for a bare wire submarine cable between England and Ireland which met with approval, and attempts, though unsuccessful, were made to lay the cable.

By nature eccentric, when Mr. Dering succeeded to the family property, he developed this eccentricity to an extreme almost beyond understanding. He was by that time a man of considerable means with property in Kent, Durham and Ireland. He built a large forge at Lockleys and employed a number of workmen whom he trained to manufacture his inventions. His theory of life was that none should work less than eighteen hours a day and he demanded scrupulous exactness in all work done for him. He was very irregular in his habits. If an important piece of research so demanded, he worked far into the night, and it was a definite rule that his dinner was to be served whenever he rang the bell — day or night. He disliked intensely any change, and refused absolutely to allow any improvements or repairs on the estate. If a tree was blown down by a storm, it had to lie where it fell. Upon the death of his father and his mother their rooms were shut up and the windows bricked in, remaining untouched till after his own death years later.

While working on his research problems Mr. Dering was collecting a library of great proportions. Plans were made by a well-known architect for a library building on the Welwyn estate, and a London bookseller had orders to send down all books on electricity which he could collect from all parts of the world. Large packing cases of books arrived continuously and Lockleys was filled with them— but they were never opened. A sudden change had come over Mr. Dering's life. He closed his forge, dismissed the workmen, and left his home just as it was, spending only a few days there each year. The touch of tragedy in this abrupt ending of such intense effort and interest is compensated by the thought that the hours Mr. Dering once planned to spend himself among his books in the Lockleys library are being spent instead in multiple measure by students who are following the same path of scientific endeavor.

One day early in 1912, the American boy, who sixty years before had been struggling with his first problems in the Morristown school, sat in his office at 15 Dey Street, New York, in consultation with a librarian from a large engineering library in the city. Theodore N. Vail, President of the American Telephone and Telegraph Company, had just heard that a large collection of books on electricity — the Dering Library — was on sale in the London book market. Within an hour a cable was on its way to England which consummated the purchase of that library. With almost equal dispatch a letter was on its way to Massachusetts Institute of Technology presenting the library to the Institute in the name of the American Telephone and Telegraph Company.

When the books arrived in Boston — ninety-six boxes of them — the Institute was about to move from the old quarters on Boylston Street to the new home just over the river in Cambridge. Rooms rented in the Massachusetts Storage Warehouse for temporary occupancy therefore became the first home of the Dering Library in this country. The problem then was the most expeditious handling of the cases — all of them very large and heavy — in order to acquire at least a complete inventory, if not a catalog, of their contents before the move into the new Tech buildings. The London bookseller's estimate of the library as offered for sale was: 6,620 bound books; 10,760 sewed books; 7,000 pamphlets; and about 40 cases of periodicals. The calculation of shelf space necessary therefore approximated 3,000 running feet, and it was decided to continue the rental of a sufficient number of rooms in the storage warehouse to enable the work of listing to be carried on there, shelves being constructed for the purpose. The cases were opened, their contents made accessible on the shelves and enumerated, and late in 1913 a special assistant was appointed to assume the work of making a simple catalog of the collection.

(Continued on page 236)

RICHARD COCKBURN MACLAURIN

By HAROLD ERIC KEBBON
Architect, Wells Bosworth, New York City

"OF the worker in science, it is especially true that the work he does, however great, however far reaching, is speedily absorbed into the general body of his science, and its individuality lost in the very growth of the body scientific to which it has contributed. Name and fame fade into the general remembrance of history, recalled for the most part by busy pioneers of the present, as the milestones of past progress, as signposts on the slowly blazed track that has brought them on the adventures of knowledge to the edge of the unknown."

I have taken the liberty of quoting the above introduction to the letters of Huxley and Agassiz appearing in the last *Yale Review*, as they seem particularly applicable to that worker in science and leader among men about whom I have the privilege of writing.

Before Dr. Maclaurin became the president of Technology, he had already achieved fame in scientific and educational circles and had published a remarkable book on "Light" which has become a classic on that subject. He had received many degrees, not alone in Science, but in the Arts and in Law; and since the day he entered the University of Cambridge, England, in 1892, up to his induction into the office of president of the Institute of Technology, his career had been marked by high achievement and by the honors and recognition that such success brings in its train.

His early career, viewed in the light of its importance to Technology, was a continuous and varied preparation for the office to which he was called later. He visited the United States and Canada after graduating from Cambridge, and studied the educational methods pursued in many of our schools and colleges, and he spent considerable time at McGill, Toronto and Leland Stanford universities.

After returning to England, he was appointed Professor of Mathematics in the University of New Zealand and later became trustee of the institution, taking an active part in organizing technical education in that colony.

In 1903 he became Dean of the Faculty of Law at the same University and he occupied this chair for four years with such distinction that the far-seeing trustees of Columbia University invited him to take the chair of Mathematical Physics which he accepted and he assumed his new duties in the fall of 1907.

At that time, the Institute was being temporarily guided by Dr. Noyes, following the resignation of Dr. Pritchett, and I remember that there was much speculation among the under-graduates as to his successor. Various names were mentioned of well known educators and scientists throughout the country, but the Institute Corporation could not come to an unanimous decision on any one of them. Finally, on November 23, 1908, the Corporation announced the selection of Dr. Maclaurin and the tension among Alumni and undergraduates was relieved, only to be replaced by curiosity as to the kind of man who was to lead the Institute through the financial difficulties and the housing problems confronting it.

The inauguration ceremonies were held in Symphony Hall on June 7, 1909, under distinguished auspices, and as we listened to the address of the new president, we were impressed by his breadth of vision and by the possibilities for greater service which his expressed hopes for Technology inspired.

During the first year of his incumbency, Dr. Maclaurin quietly surveyed the conditions at Technology and he soon realized the necessity of removing the Institute from its crowded quarters to a new location and of establishing it on a sound financial basis by creating an endowment fund. His quiet and yet forceful personality gained the complete confidence of the Alumni and helped to unify the Corporation and the Faculty.

One of the first fruits of his endeavor was the gift from T. Coleman Dupont of half a million dollars towards the purchase of a site for the new buildings and the news of this gift kindled such great enthusiasm among Tech men that all thoughts were turned towards the future. Then came the rumor of a new and greater gift of two and one-half millions of dollars from an anonymous source, thus assuring the future by permitting the preparation of preliminary plans for new buildings. We heard the glorious news at a mass meeting in Rogers Hall, at which Dr. Maclaurin announced the gift as coming from "Mr. Smith." It is only within the last few years that the identity of "the mysterious Mr. Smith" has become known. At this same meeting, in referring to the donor and the effect of his princely generosity on the Institute, he quoted Emerson in saying that "every institution is the lengthened shadow of a man." How true it is if we think of Dr. Maclaurin in this connection.

After considering various possible sites in and near Boston, the present location was decided upon. At that time it was a dismal swamp which was being gradually reclaimed by vicarious contributions of miscellaneous debris. But Dr. Maclaurin had the vision to see the wonderful æsthetic potentialities of the river frontage and its strategic location with regard to transportation facilities.

During this period the students became greatly attached to their president and Mrs. Maclaurin, who opened her home to them, receiving sixty or

THE TECHNOLOGY SERIES

Last year THE TECH ENGINEERING NEWS published a series of articles on the buildings, laboratories and business administration of the New Technology. This series met with such widespread approval among our readers that we are continuing the idea this year. Our new series will be of a slightly different character, dealing with the great personalities and the more human side of the Institute. As our space limits us to only a bare outline of the subject, it is hoped that the new series will serve as an inspiration to further reading along this line. The topics which the series will cover are as follows:

THE FOUNDERS OF THE INSTITUTE ..... October
Prof. H. W. Tyler, Head of the Department of Mathematics.

FRANCIS AMASA WALKER ..... November
J. P. Munroe, Secretary of the Corporation, M. I. T.

RICHARD COCKBURN MACLAURIN ..... December
Harold Eric Kebbon, Architect.

A HISTORY OF THE SOCIETY OF ARTS ..... January
Prof. H. M. Goodwin, Department of Physics.

A HISTORY OF THE DEPARTMENT OF ARCHITECTURE..... February
Prof. William Emerson, Head of the Department of Architecture.

A HISTORY OF THE DEAN'S OFFICE..... March
Author to be announced later.

RELATION OF INSTRUCTOR TO STUDENT AT TECHNOLOGY ..... April
Prof. L. M. Passano, Department of Mathematics.

GREAT GATHERINGS AT TECHNOLOGY..... May
Author to be announced later.

seventy undergraduates on successive Saturday evenings until the majority of them had been recipients of her warm and generous hospitality. By reason of this social contact a new element of great value to the students was introduced into Technology, for the first time in many years.

During 1912-1913 the plans for the new buildings were prepared and it was during this time and throughout the period of construction that I came into closest touch with Dr. Maclaurin and realized his quiet resourcefulness and his great qualities. The problem of apportioning the necessary floor space among the different departments of the Institute was the task of a diplomatist and after many conferences Dr. Maclaurin prepared a program of space assignment which was satisfactory to everyone. In this work it was my privilege as resident architect to assist him, and my admiration grew daily as he tactfully and with firmness determined upon the size, location and equipment of the various laboratories, class rooms, offices, etc., incidental to the working out of the plans as a complete entity.

In the fall of 1913 the construction work actually began and during the two succeeding years the buildings gradually assumed shape. Throughout the construction period there was not a detail that escaped Dr. Maclaurin's vigilance. He forfeited his summer vacations in order to give the work his constant attention and the benefit of his unflagging interest and devotion. The financial problems connected with the undertaking were very great at certain periods in this work, but his decisions were always immediately and fearlessly given with unfailing good judgment.

During this time the plan for the amalgamation of the engineering schools of Tech and Harvard was consummated by Dr. Maclaurin and President Lowell. This proposal which, in a similar form, had been seriously opposed by the Alumni during a previous regime, was enthusiastically received by the majority of Tech men because of their implicit faith in the aims and purpose of their new president. The union with Harvard caused a readjustment of courses to be made and introduced Harvard professors and equipment into the Technology domain, but this transfer was accomplished without the appearance of petty jealousies or professional discontent.

Finally at the end of three years, the new group of buildings was completed and a splendid white city of educational buildings, laboratories, workshops, and including the Walker Memorial, Dormitories and President's House had arisen out of the waste land.

Technology's farewell to the old buildings in Boston and its induction nto its new home was featured by a three-days' celebration in June of 1916, beginning with a great pageant and masque in which Dr. Maclaurin and the Faculty were transported across the Charles River in a stately barge and were received on the Cambridge shore by the Governor of Massachusetts and members of the Corporation. The crowning event, of course, was the formal dedication of the new buildings held in the great court and attended by thousands of Alumni and representatives of the higher institutions of learning of this country and of Europe. At the banquet which followed, Dr. Maclaurin made the further announcement that the "mysterious Mr. Smith" whose generous donations had already made largely possible the new buildings had agreed to further contribute several million dollars to help create an endowment fund, fulfilling the second great need of the Institute.

Courtesy The Technology Review

RICHARD COCKBURN MACLAURIN

One year later found our country entered into the World War, and during those trying times Dr. Maclaurin threw open the doors of Technology to the Government, converting the buildings into barracks and transforming the open spaces into aviation camps.

All this was accomplished without disturbing the regular courses of study and during the year and a half after the Armistice was signed, Technology flourished as its founders never dreamed was possible with an enrollment of over three thousand students as compared with a registration of one-third of that number at the time Dr. Maclaurin was inaugurated.

But these years of ceaseless effort and heavy responsibilities had left their mark on our beloved leader, and with the future of Technology assured and his great labor accomplished, our president was stricken and taken from us.

At the Alumni banquet held in the Walker Memorial in January of 1920, his valedictory was read to us as we gathered to praise him. A few days later the news of his death spread sorrow throughout the Alumni body and created among those of us who were privileged to know him intimately, the deepest sense of personal loss.

It is to be hoped that the memory of the work he did may not be lost in the continued progress of our great school and that one of its buildings may receive his name as a perpetual reminder of its great pioneer president who found Technology "in wood and left it in marble."

The new Technology may well be said to be the lengthened shadow of Richard Cockburn Maclaurin.

Aeronautics to be Taught at New York University. After an exhaustive study of the field of aviation in the United States, New York University has inaugurated courses in Aeronautical Engineering and Industrial Aviation in its College of Engineering at University Heights. The establishment of these courses is part of a plan to advance the study among American youth of the designing and utilization of commercial airplanes and to develop among college students a body of highly skilled aeronautical engineers.

The plan has been given the financial support of a large group of famous pioneers of aviation, airplane manufacturers and operators and business and professional men.

The new courses at New York University cover specifically the study of aerodynamics, the science of air flow and forces, the theory and practice of airplane design, the theory and practice of dirigible design and the study of aircraft engines. It is the object of these courses to train men who will advance the art of aircraft design and construction in a thoroughly practical yet scientific manner.

In the work in industrial aviation attention is concentrated on air transportation, passenger and freight, on an extensive study of air mail operations, the organization of landing fields and airways, the technical and financial analysis of aviation projects and on such industrial applications of the airplane as aerial photography, now being used on a large and increasing scale; as aerial surveying, which is proving an invaluable adjunct in public service work, and in engineering enterprises of all kinds, such as forest patrol and surveying, aerial advertising and numerous other industrial applications.

HUMANICS AT NELA PARK

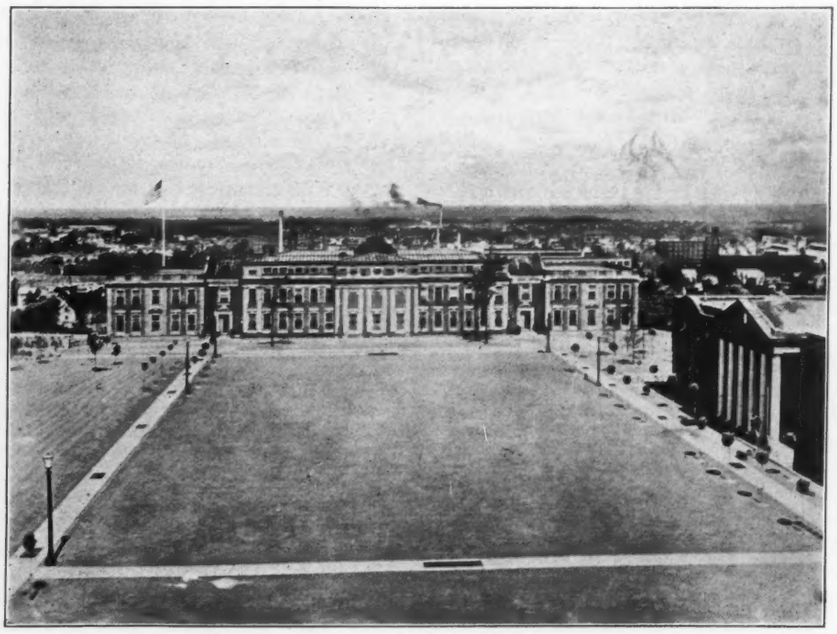
By HENRY ZEIGER, '24
Brookline, Mass.

Humanics is the doctrine or science of human nature or of matters relating to humanity. — *Century Dictionary.*

IN our modern industrial society the test of the basic soundness of an institution is its continued profitable progress. Profits may occur in various forms: as better citizens for the community from a university; as healthful recreation to members of a country club; or as money dividends to stockholders of a corporation. In order to first win support an institution must promise profits, and in order to hold that support it must progress profitably. This may be thought of as the governing motive explaining most of the actions of our commercial institutions.

Viewed from a broad perspective we may conceive of our large industrial structure as a working agreement of three parties or classes. This agreement is usually unexpressed and even unrecognized by all the parties concerned, although the class consciousness of two of them has in some cases forced written working agreements. However it is none the less real that there are three parties to the bargain, and no organization can function without all of them. First there is labor, whose manual execution of certain assigned tasks is usually the finishing process of actual production. At the other extreme is capital, that very real force driven by the colorless, concentrated personality of thousands of stockholders, which is in active control, and is represented by the officers of the organization. Between these two extremes is the third group, servants to capital and nursemaids to labor, without whom neither could function, and blindly refusing to assert its own class importance, the great middle class. From this class comes forth the brains of industry, the executive managers, technicians and legal advisors, who as a group plan and issue actual orders of production; the accountants and clerks who check up on production; and finally the sales managers with their organizations of salesmen who distribute the product.

Low cost quantity production is an exact science of Production Methods, and presents no insurmountable obstacles to the efficiency expert; financing problems can be solved by banking and accounting technique; but the securing of voluntarily given best efforts of the middle class of brain workers, who must create, supervise and distribute, is a problem in humanics too long neglected, and worthy of the best efforts of our greatest minds. A few corporations have seen the new light and are attempting solutions, but the rest take as one of the natural afflictions of doing big business, a greatly reduced efficiency and loyalty from their brain workers, over what these people would put forth were they working for themselves.



ENGINEERING BUILDING AND CAMPUS

A most interesting and evidently satisfactory solution has been brought about at Nela Park, Cleveland, where is located the home office headquarters of that vast organization, the National Lamp Works. Here on a broad hillside on the outskirts of Cleveland, is a small community curiously distinct and apart from its surroundings. A person walking through cool green campus, under inviting shade trees, past mirror-like pools of water and tennis courts populated with white flanneled figures, would find no difficulty in believing himself on the grounds of a very pretty if a rather quiet university. If then he were shown the various buildings in their true light as humming hives of industry, the administrative, executive and research headquarters of the National Lamp Works, our hypothetical friend would, if he were normal, wonder, "How do they do it." And were we close at hand, we should, while ignoring the question, tell the following story.

It was not pure brotherly love or an advance premonition of the approaching millennium that prompted the authorities here to give the employees such healthful, ideal surroundings. All was part of a carefully conceived plan of men with vision for "getting from the brain workers that which cannot be bought," as Mr. H. Robert Crouse so ably expressed the issue. These men had the foresight to perceive that a feeling of enthusiastic loyalty and creative initiative could be developed in their brain workers all down the line if properly cared for. The result is this beautiful group of buildings set in landscape gardening, which has had the unsolicited honor of being named "The Best Kept Plant in America."

But park-like surroundings alone will not solve this perplexing problem. In order to produce desired reactions appeals must be made to the deeper instincts existent in normal men and women. Whether done consciously or not, the prime movers at Nela Park have followed this plan of thought.

Necessary to the proper functioning of an organization, doing a vast nation-wide business, both of manufacturing and selling, are a number of widely differentiated activities. In addition to the normal managing through executives, and record keeping by accountants, we have departments of advertising, research, lamp development and a host of others. In their proper functioning, these activities are

(*Continued on page 226*)

IMPORTED AUTOMOBILE SHOW

By CHARLES A. CHAYNE, '19
Mechanical Engineering Department, Massachusetts Institute of Technology

THE New York foreign car shows presented little that was new as regards design. With the exception of the 10–40 Mercedes the chassis were practically the same as those exhibited last year with no more changes than normally made during a year's development of a successful design.

While the 10–40 Mercedes supercharger model has been on the American market since last spring, this is the first show in which it has been exhibited. With the exception of the rear springs, which are of the cantilever type, the chassis follows normal Mercedes practice. The engine follows post-war Mercedes practice in the use of a cylinder block built up of steel forgings welded together. The engine is comparatively small, having a bore and stroke of 80 mm. x 130 mm. ($3\frac{3}{16}$" x $5\frac{1}{8}$") giving a displacement of about 164 cubic inches. Two valves per cylinder are mounted in the cylinder head and are operated by an overhead camshaft driven from the rear end of the crankshaft by means of a vertical shaft and bevel gears. One spark plug is fitted in each cylinder and is mounted on the intake side at a considerable angle. The inclination of the plugs should eliminate the difficulties experienced in preventing the oiling up of horizontal plugs.

The real novelty of the machine is in the system of forced induction by means of a supercharger. Mounted at the front of the engine is a small blower of the Roots type. This blower is mounted with its spindles vertical and is driven from the front end of the crankshaft by means of a friction clutch and bevel gears. A stove is fitted to the exhaust pipe and is provided with shutters so that the temperature of the air may be regulated very nicely. Two pipes run from the stove, one forward to the supercharger and one through the block to the carburetor. The delivery pipe from the supercharger is slightly smaller in diameter and is led directly to the carburetor. The carburetor air inlet is fitted with a valve so either the blower pipe or the atmospheric pressure pipe may be connected to it.

The carburetor is a special Mercedes, designed especially for use with a supercharger. A point to be noted is that in a system of this type the carburetor and intake manifold must be absolutely air tight. As the float chamber must be under the same pressure as the incoming air, means must be provided for increasing the pressure of the gasoline feed when the supercharger is in operation. This is accomplished by having an impelling pump mounted on the forward spindle of the blower which boosts the fuel supply when in operation.

The air valve and supercharger clutch are connected to the throttle pedal in such a way that they are not operated until it is pushed beyond the normal full throttle position. The operation of the car is therefore perfectly normal up to wide open position, beyond that the supercharger is brought into action. While exact performance curves are not available, the maximum power without the supercharger in action is about forty, which appears to be normal for a well designed engine of this size. With the supercharger however, the power is said to be around sixty-six.

The acceleration and speed of this car are said to be remarkable. The Mercedes supercharged race cars entered in this year's Indianapolis race, while being extremely heavy two-man cars and having four cylinders, showed accelerating ability equal to, if not slightly better than that of the lighter one-man eight-cylinder cars. The eight-cylinder Fiat cars using a somewhat different type of supercharger have proved to be the fastest cars driven in the European races this year. Judging by this the claims of the supercharger seem to be well founded and seem to offer a solution of the problem of designing a car which is soft and docile in traffic but when necessary has all the acceleration and speed which can be used.

Mercedes also exhibited the 28–95 six-cylinder car. This model is also of the steel cylinder type but was not fitted with a supercharger.

The Steiger car was shown for the first time in this country and is notable chiefly for its remarkable stroke-bore ratio, about 2.2 to 1, the dimensions being 62 mm. x 160 mm. (2.44" x 6.29"). The engine is of the overhead camshaft with a fixed head. The intake valves are mounted in cages so that they may be removed without removing the block. An interesting feature is the mounting of the generator at the rear of the overhead camshaft. The addition of the generator load to the rear end of the camshaft is apparently intended to steady the load on the camshaft drive.

Voisin exhibited their two models, one known as the 8 h.p. having a four-cylinder Knight type engine having a bore and stroke of 60 mm. x 110 mm. (2.36" x 4.33"). The chassis of this model is very much like the larger model, the most interesting features being the use of a single unit electric system with the starter-generator mounted at the front end of the crankshaft. This location seems to have much to recommend it on the score of simplicity and accessibility and also in its use as a torsional vibration damper.

The larger Voisin is the 18–23 h.p. model having a bore and stroke of 95 mm. x 140 mm. (3.74" x 5.51"). The chassis is without doubt one of the cleanest designs shown in this country. The engine is also of the Knight type, an interesting feature being the provision of an oil feed to the cylinder walls on both sides. The

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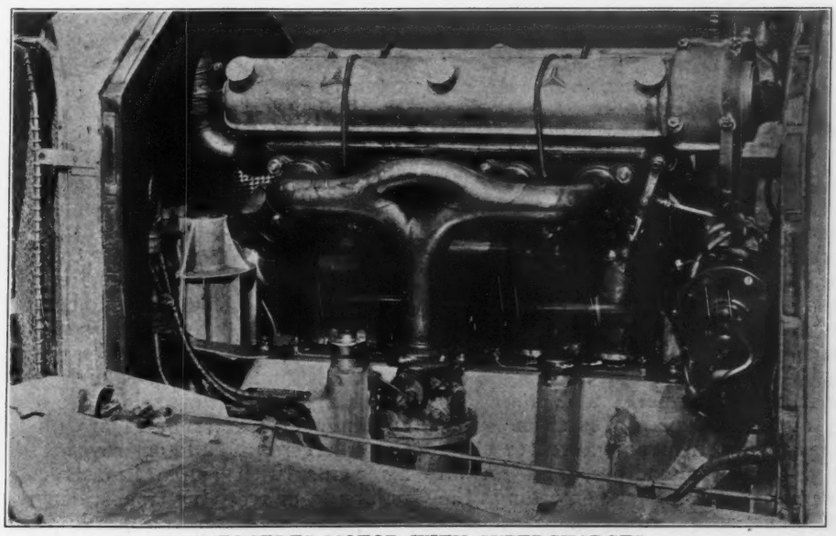

MERCEDES MOTOR WITH SUPERCHARGER

THE RAILWAY FREIGHT SITUATION

By JOHN A. DROEGE
General Superintendent, New York, New Haven & Hartford Railroad
Author of "Freight Terminals and Trains" and "Passenger Terminals and Trains"

THE terminal problem of the railways far outweighs the line haul in cost and effort; is greatly affected by geographical and topographical conditions, and is intensified and aggravated in its complexity by the extent to which the higher class commodities predominate.

Any studies to bring about increased efficiency of operation of terminals are met with discouragement, if not actual defeat, by one or all of these factors. The actual cost of transportation performed by the American Railways is marvelously low; it may be stated in general terms as about five or six mills — a half of a penny — per ton-mile, or we may use a homely illustration by telling the story of the manager who replied to a complainant's letter. The value of the postage stamp affixed to this reply was equivalent to the cost of hauling a ton of freight three or four miles. It is all the more astounding when we further consider that even this low cost includes the terminal expenditures which are ordinarily many times that of the line haul. In a carefully worked out analysis it was shown that a ton of freight moving from Philadelphia to New York, a distance of ninety miles, required fourteen times as much for the outlays at the two terminals as for the line haul proper. These terminal costs included the handling of the freight through the receiving house, waybilling, checking, loading into car, switching, and at the other — the New York end — likewise, the breaking up of train, switching out of car, placing in designated yard (or track) loading onto float, towing, unloading alongside New York pier, trucking, checking and delivery to consignee's team. It is true that this is possibly an extreme case. There is no accurate segregation of accounting, but we know that elimination of the terminal costs leaves the actual line haul cost of American Railway freight service exceedingly low, and undoubtedly lower than any other form of transportation. It may be taken for granted, as intimated in the beginning of this article, that the relatively higher costs of the terminal operation occur with a correspondingly shorter line haul; that they are higher in thickly settled and built-up communities, particularly in older sections — as will be explained later on — and are greater on manufactured or other high-class commodities, and on an increasing scale far exceeding the difference in freight rates.

For every three miles of standard railroad track in use in the United States there is considerably more than one mile of switching or terminal tracks. In the eastern section there are roads with nearly as many yard or terminal track miles as of road miles. Some of the more important roads produce switching mileage as high as forty and fifty per cent of the entire number of revenue train miles, and in essentially terminal regions even eighty per cent. The actual average road miles made by freight cars daily is exceedingly low — somewhere around twenty-five miles a day.

The development of the motor truck and its unfair, subsidized competition for the railroads' high-class freight has been followed in some instances by its utilization to aid in solving the terminal problem by substituting or supplementing it to the rail haul. This has been widely discussed, and several quite extensive adaptations of the motor truck service have been and are being tried out, but the practicability has not as yet been fully demonstrated. It may prove helpful in extending the service of the railroads to direct or "store-door" delivery. The assembly of full carloads of package freight at one station instead of several stations, by means of motor trucks, necessitating the use of a lesser number of cars to handle the freight, will ease up the terminal problem in some instances. Lightly loaded cars, destined to stations near others with heavier loading have advantageously been combined at the loading point and contents trucked at final destination of the car to the nearby stations; thereby eliminating car mileage and expediting freight movement. This light-car-load freight question is a big one, and a serious one, which has become more difficult with the advent of the motor truck, which tends to reduce the number of straight destination cars by cutting down the amount of freight available for solid car loading. A large road found that while its light-car-load freight only amounted to less than ten per cent of its total tonnage, it required about forty per cent of its car days to handle it.

The conventional and, more or less, theoretical methods by which the operating officer would increase the efficiency of his terminals are, first the enlargement and (or) revision of his yards, with ample lead tracks; pulling in or receiving tracks; departure yards; classification yards with sufficient body tracks of proper length; humps; engine houses and all their accessories; freight houses; transfer platforms and all the related facilities. His next move, logically, would be, in correlation with or in sequence to his better terminal arrangements, to secure the greatest practicable train-load; the heaviest feasible car-load; prompt movement of trains and rapid turning of engines.

In his efforts to increase his terminal capacity, he almost immediately runs amuck. Roads in comparatively new country, with long average line hauls — some running up to three hundred miles — usually have ample room for such extension of terminals and little need of it. Contrariwise, in older communities, such as the Eastern States or more specifically the roads along the waterfront in Southern New England; with an average line haul of perhaps less than one hundred miles — with a great preponderance of terminal work, in proportion to the line haul, and with something like ninety-five per cent of cars received from lines with which they connect, for destinations on their own rails — there is great need for ample terminal facilities, and the cost of such facilities is almost prohibitive. A western road may, for instance, provide team delivery track space, land included, for $300 per car length. In the thickly settled, and topographically unfavorable New England section, this would doubtless cost anywhere from three to fifteen times as much; the same approximate proportions obtain in construction of freight houses, and of other facilities. With the compensation based substantially on the distance hauled, the paradoxical aspects of the situation are apparent. The lines in thickly built up regions, with their short hauls and the natural accompaniment of good hard-surfaced highways as competitors are compelled, for their own protection, to keep their freight facilities near the commercial centers, where real estate values are greater, while their more fortunate allies, of the sparsely settled regions, long hauls, fewer improved highways, take advantage of low priced and roomy outlying sections for their improvements. It is obvious, therefore, that the New England roads were hard hit when they were compelled to train along in the change from the mileage system of paying for the use of other roads' freight cars to the per diem system,

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THE ORGANIZATION OF A BUREAU OF HIGHWAYS

By MAJOR F. S. BESSON
Acting Engineer Commissioner, Washington, D. C.

THERE are certain fundamentals of organization that are of importance to all municipal officials responsible for the design, construction and maintenance of city streets. They are also of interest to every private citizen in his capacity both as a city dweller and as a taxpayer. City pavements cost more than any other work of construction carried out by a municipality, but, in many cases, the work is undertaken with no proper organization for its performance.

In a village or small town it is evidently possible that an engineer, in addition to pavement construction and maintenance, might personally supervise all such matters as water supply and sewers, bridges, lighting, street cleaning, snow removal, the collection and disposal of garbage, ashes and rubbish. As the municipality grows, the details of these several tasks become too great for any one man to handle them, and it is imperative that there should be created a Department of Public Works with separate subsidiary bureaus, one being that of Highways, including all work connected with the laying out, construction and maintenance of streets and alleys.

In many cities this same bureau is charged with street cleaning and the collection and disposal of refuse, work which is of major importance, but is entirely dissimilar to that pertaining to the construction and maintenance of the city pavements. The combination in one bureau of two unrelated and independent activities means that the engineer in charge must have under him two division heads, one in charge of paving work, the other in charge of street cleaning and the removal of refuse. Experience is believed to have shown that it is a much better plan to have a Bureau of Highways charged solely with the construction and maintenance of pavements, and a Bureau of Refuse (including street cleaning and the collection and disposal of all refuse), the head of each reporting to the Director of Public Works.

The precise organization of a Bureau of Highways depends largely upon local conditions. However, the principal work to be done by such a bureau is, in all cases, so similar that it is possible to outline in general terms the form which this organization should take. The work of the bureau is divided into two distinct, principal classes, construction and maintenance. There may also be several minor classes of work.

There are certain municipal activities or functions which, while they concern the Bureau of Highways largely, yet should be handled by separate agencies. Such are those pertaining to filing and mailing, blueprinting and duplicating, purchasing, the accomplishment of contracts, auditing and accounting, motor transport and mechanical shops. Other bureaus, such as water supply, sewers, and the like are equally interested in the proper performance of the functions just outlined, but there will be a saving in overhead and a gain in efficiency if, as suggested, these matters are all handled by central bureaus.

Having sketched the duties of the Bureau of Highways, an organization for carrying on the work may be considered. There are two forms of organization, centralized and decentralized, and what may be classed as a third, being a combination of the two.

The centralized form is common in business life, as for example, a corporation may have purchasing, manufacturing, selling and other departments. Agencies of each of these may be established in various territories, working independently of each other, and reporting directly to departmental heads in a central office. In this case specialists are developed. Central office authority is at a distance and action is slow. This authority may not be well informed as to local conditions and one service may work at the expense of another. These points may, however, be of minor consideration since the nature of the business demands, above all, expertness and uniformity of method in each separate activity.

A contractor engaged in a particular line of construction throughout a large part of the country generally adopts the decentralized form of organization. Each separate territory is in charge of a man with full local responsibility who has to act on his own initiative and make quick decisions. Work has to be adapted to local conditions. In this form of organization, all-round men are developed. Jobs in neighboring territories enter into competition and pride is taken in having the best unit in the organization. All these points are of first consideration. Uniformity of operations among the several territories is of secondary importance.

A military organization is the outstanding example of a combination of the centralized and decentralized forms, the former to insure expertness, the latter to insure direct command and speed. In time of peace the tendency is more toward the centralized and in time of war toward the decentralized. Coördination of the two is at all times necessary. Specialists in the various services (supply, medical, air, engineer, etc.) must not interfere in local operations without the knowledge of the unit commander.

The larger a city the greater the necessity of following the military organization. State highway departments have found the system particularly adapted to their needs. The Engineer of Highways has two principal expert advisors, the Engineers of Construction and of Maintenance. The work in the separate territories is in charge of local men called District Engineers, each District being in reality just like a small city.

It is a question when, as a city grows, division into districts should be made. No two cities are alike. Many different physical, financial and other conditions must be considered and again, much depends upon the personal qualities of the engineer in charge. Generally, in a fairly prosperous and progressive city of twenty thousand inhabitants, paving work alone is of such importance that the appointment of an Engineer of Highways is well justified. As the city grows, his organization should conform to the general rules already set forth. In expanding, the first step is the employment of a District Engineer, and next, the formation of additional districts. Feeling the need of assistance in correlating the work of the District Engineers, the appointment of either an Engineer of Construction or of Maintenance is made, for instance the latter, while the Engineer of Highways personally directs construction work. Finally, an Engineer of Construction is also employed.

One essential and practically universal difference between the work of construction and that of maintenance is that the former is habitually done by contract, the latter by day labor. The relative importance of these two classes of work depends upon circumstances, and, as these may vary, one or the other class may be more important. Maintenance must pro-

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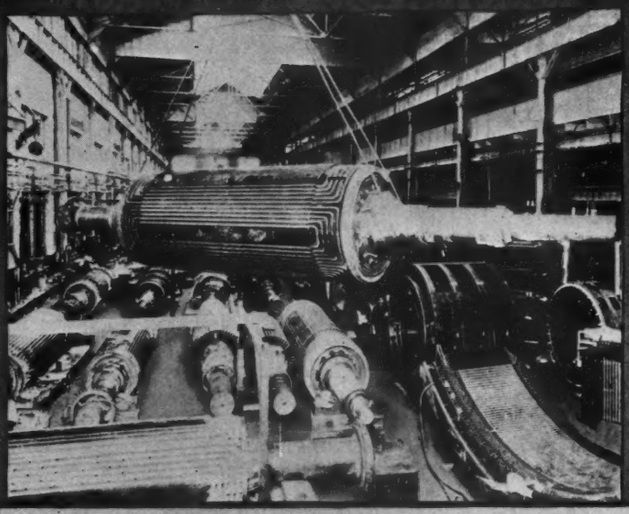
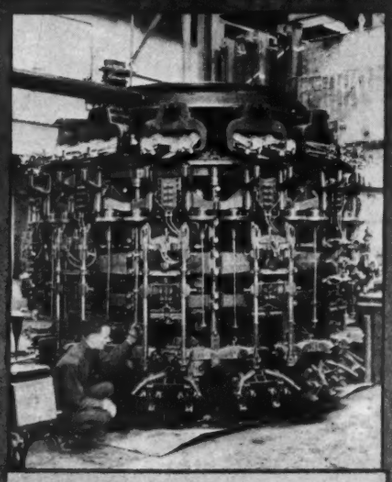


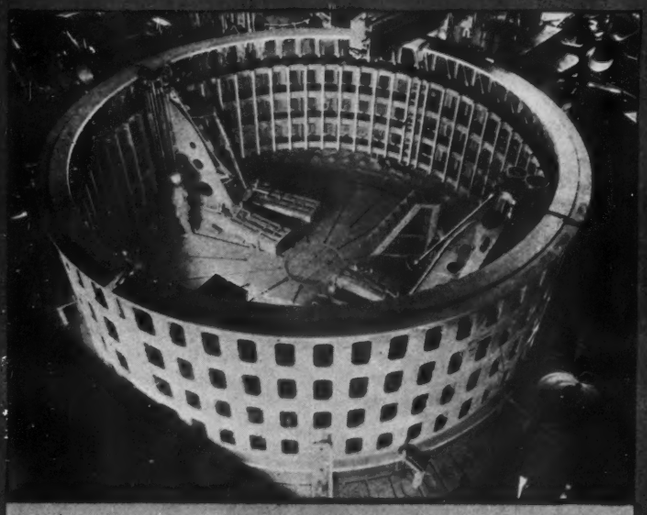
ONE OF THE THINGS WHICH MAKES ELECTRICITY

This shaft or armature, weighing 205,000 pounds or 102 tons, will be used by the Brooklyn Edison Company to develop 62,500 kw., which is power enough to light 1,300,000 of the household type of Mazda lamps. Despite its enormous weight, this armature will revolve 20 times per second. It is 35 feet long and more than 6 feet in diameter and is one of the largest ever made for this purpose. It is being manufactured at the General Electric plant at Schenectady.



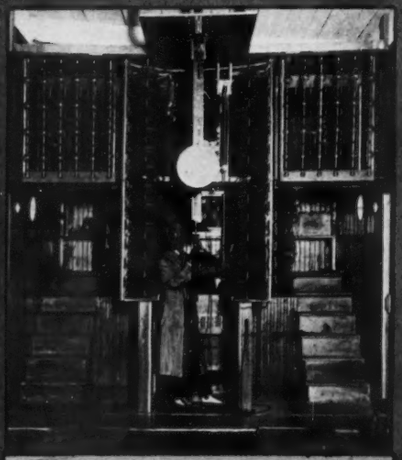
A MECHANICAL GIANT OF THE LAMP INDUSTRY

This machine, containing a total of 14,000 parts, is used for blowing incandescent lamp bulbs and has a working capacity of 50,000 bulbs a day. It is used by the General Electric Company at its Schenectady plant.



THE LARGEST GENERATOR IN THE WORLD

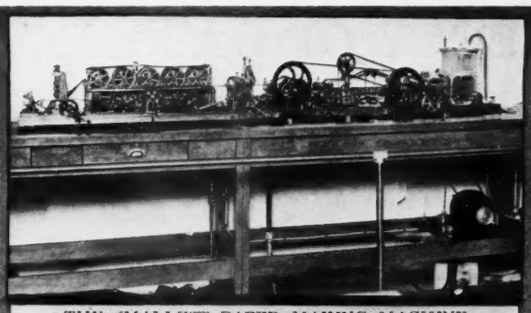
The largest generator in the world is being installed by the General Electric Company for the Niagara Falls Power Company, on the American side of the Falls. This machine, when completed, will supply 87,000 horsepower. The electric power generated will light more than two and a half million household Mazda lamps, which is sufficient to supply the electrical needs for a city of the size of Boston. Each generator—there will be two—will weigh 700 tons, will be 26 feet high and 35 feet in diameter.



ELECTRIC BULB INVENTED TO BURN THREE YEARS WITHOUT ANY CONNECTIONS

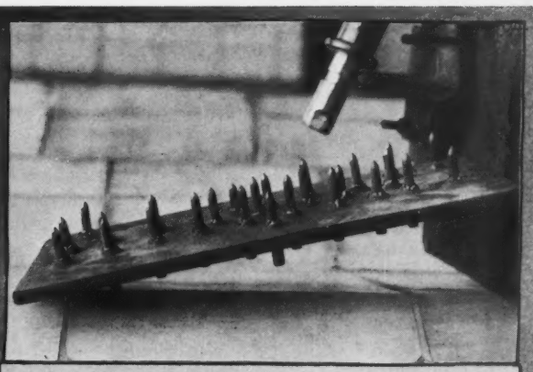
An electronic lamp, self-contained, complete in itself and requiring no connection whatever after being lighted with any source of power and designed to give off continuous light of undiminishing intensity for a period of three years, is an invention of J. J. Tomadelli. He has carried the revolutionizing development so far as to organize a corporation and purchase a plant to place it before the world on a large scale. His generating apparatus gathers electrons and transmits them to the bulbs which then may be carried about like a lamp, without being refilled, for three years according to his statement. The principles involved are described as including two distinct features—the lamps containing the energy and the apparatus necessary to start activity of energy within the lamps.

International News Reel



THE SMALLEST PAPER MAKING MACHINE IN THE WORLD

This is the smallest paper making machine in the world. It shows the machine in operation at the Coliseum during the Graphic Arts Exposition. This miniature machine, which is the only one of its kind in the world, is less than nine feet in length. The average paper making machine is more than 200 feet in length and weighs several thousand tons. Some of the bearings and gears in this miniature machine are as fine as a watch. It has every operation for the making of paper from the time the pulp is fed to the grinder through every process necessary to produce paper. The paper comes out in widths of four inches.

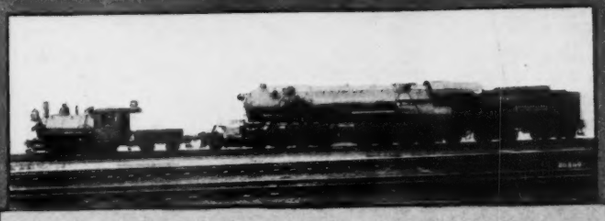


GUN WILL SHOOT FIVE TONS 300 MILES

The rivetting gun in its holder and the 3-4 inch steel plate showing the steel slugs shot into it with the remarkable new gun.

A gun that, in the opinion of Dr. Miller Reese Hutchinson, noted American inventor, "will make war too terrible for nations to engage in it," has been invented by John Temple, a British subject now residing in the United States.

The invention is now in the form of a small rivetting gun which was demonstrated in the Woolworth Building, New York, today before a group of distinguished scientists, inventors and ordnance experts. Its proposed giant counterpart will employ the same principle used in the small rivetting gun and the monster war weapon, the experts declare, will be able to hurl a five-ton projectile from 200 to 300 miles.

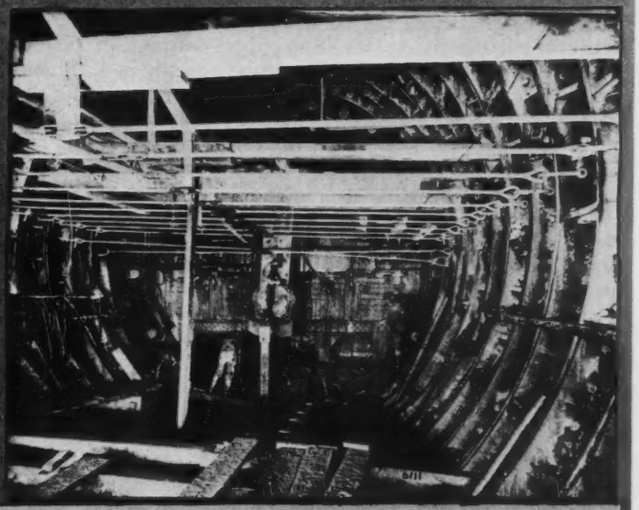


THE LONG AND SHORT OF IT IN RAILROADING

Here are the long and short of it in railroad circles—the largest and smallest locomotives of the Philadelphia and Reading lines. The small engine is used only for yard duty, but the large engine is of most modern design and construction for passenger train service.

A NEW DITCH DIGGING MACHINE

The 90-ton 120-horsepower ditching machine used on the Albert Lea drainage project in Southern Minnesota is mounted on two wheels and two crawlers. A revolving wheel cuts the ditch to its finished shape and a conveyor belt carries the material 20 feet from the line of the ditch depositing it in a spoil bank. With a crew of five men a quarter-mile run is an average for a 10-hour day.



WORK RAPIDLY PROGRESSING ON VEHICULAR TUNNEL UNDER HUDSON RIVER

Photo shows part of the great vehicular tunnel in course of construction, under the Hudson River. When completed, this under-river passageway will provide one of the finest roads for vehicular traffic, linking the two states, New Jersey and New York.

International News Reel

INCREASING THE EFFICIENCY OF GASOLINE[1]

By DR. G. CALINGAERT
Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology

THIRTY years ago the first automobile had not yet been built in this country. Today there are about eleven million motor vehicles in the United States — one for every ten persons in the country. Automotive transportation, of which a large future expansion is assured, is dependent for its existence upon an adequate supply of liquid fuel. The use of motor vehicles has been built up around gasoline, a material which only a few years ago was a troublesome by-product of petroleum refineries. As the number of automobiles in use increased, this product, for which there had been very little demand previously, was gradually absorbed, until about 1905 there was no longer a sufficient supply of the early highly volatile gasoline to operate the motor vehicles in use.

At this point gasoline began to assume a higher place in refinery economics. It was no longer a by-product; but its production was extended in order to keep pace with the development of motor transportation, until it has now assumed prodigious proportions. In 1921 the production of gasoline in the United States was over five billion gallons. This means that the petroleum refineries in the United States are filling a ten-thousand-gallon tank car with gasoline every minute of the year.

Since 1909 the number of motor vehicles in use in the United States has increased over three thousand per cent, while during the same period the production of petroleum has increased only about one hundred and fifty per cent.

It is obvious from these figures that something must be done towards providing the necessary amount of fuel to keep this rapidly increasing number of motor vehicles in operation.

Let the geologist decide whether our output of petroleum can be made to keep pace forever with the rising demand for motor fuel. Let the chemist find out whether other sources of liquid fuel can be made to meet the demand. Before they can answer our questions effectively, we will ask the physicist if he can help us solve the problem. His answer is that we ought to increase the fuel economy of automotive engines.

The best way to accomplish this result is to increase the efficiency with which the energy of gasoline is utilized in automotive equipment, and thereby to obtain more "automobile-miles" per gallon of fuel.

The solution of the problem appears very simple. According to the laws of thermodynamics, the fuel economy of an engine is increased as its expansion ratio (in automotive practice, called compression ratio) is raised. Logically, then, the next step is to increase the expansion ratio of the motor. This is accomplished by reducing the clearance volume above the piston, which in turn increases the pressure at which the fuel mixture undergoes combustion.

Unfortunately this new engine does not function properly but, when running on gasoline, it gives a very objectionable and disturbing noise. This noise, which is metallic in sound, is called by motor mechanics a "knock," the term usually being qualified by an adjective such as "carbon," "spark," "heat," or "fuel."

The knock is a sharp ringing noise, suggestive of two metallic parts striking together, and is most pronounced when the engine is pulling at slow speeds in high gear, as is the case on steep grades or when accelerating from slow speeds. This noise is not caused by the striking of metallic parts, but it has been fairly well established that it results from a detonation of the highly compressed fuel mixture in the combustion chamber.

For any given fuel the intensity of detonation varies with the compression of the engine — the higher its compression the more pronounced the detonation. While the detonation that occurs in automobile engines of present compressions is so slight as to be merely an unpleasantness that does little or no harm, in engines of highly economical compressions its intensity becomes so great as to result not only in loss of power but also in actual damage to the engine. This phenomenon of detonation, then, stands as an effective barrier to the obtaining of better fuel economies from internal-combustion engines, and because of this fact, it has an important economic aspect.

In spite of the fact that gaseous detonation is not well understood, many theories have been advanced to explain the phenomena that occur in internal-combustion engines variously known as "detonation," "knock," and "pinking."

It is not the purpose of this article to discuss these theories, and we refer the reader to the luminous discussion of the subject presented by Thomas Midgley, Jr., (Journal, Society Automotive Engineers, *10*, 1922, 361), where a complete mathematical treatment of the problem will be found. According to Mr. Midgley's theory, the metallic sound, commonly called the knock, is caused by this high-pressure, high-velocity wave striking the top or sides of the combustion chamber.

This theory is in complete agreement with the behavior of the various fuels tested in internal-combustion engines, whereas none of the other theories advanced could account for the various conditions under which "knock" takes place or can be suppressed.

It is well known that if substantial percentages of benzene or alcohol are mixed with gasoline, the product can be used in motors of fairly high compressions without the objectionable knock. But unfortunately forty to sixty per cent of one of these materials must be added to gasoline to accomplish the desired result; and so the amounts of benzene and alcohol available are sufficient to treat only a very small part of the gasoline that is consumed.

As a result, a large amount of work has been done on this problem by the General Motors Research Corporation, and it has been found that detonation can be either suppressed or induced by the presence of very small amounts of certain materials in the combustible mixture. These substances may be dissolved or suspended in the fuel, or they may be admitted to the combustion chamber in some other way. The action of practically every type of compound that should affect detonation has been tried, and a large number have been found to possess the property of affecting combustion in such a way as either to suppress or induce detonation.

As the tendency of kerosene to knock is much greater than that of gasoline, all the tests reported here were made on kerosene, thus rendering the experiment easier and increasing the accuracy of the results.

If the high-velocity, high-pressure wave theory of detonation is correct, the action of these materials is to affect the reaction velocity of combustion in such a way as either to accelerate or retard the tendency of the combustion to reach the velocity of detonation. Because of this effect, substances which, when present in small percentages, exert a powerful suppressing action on detonation have been termed "Anti-knock materials," or "compressionizers." Thus, diethyl

(*Continued on page 221*)

[1] Most of the data in this article are taken from the publications on the subject by Mr. Thomas Midgley, Jr., Chief Engineer of the General Motors Research Corporation. See *Journal of Industrial and Engineering Chemistry*, *14*, 589, 849, 894 (1922).

ALDRED LECTURES

INTRODUCTION

PRESIDENT STRATTON: During the latter part of the past year some of us were very much interested in inaugurating a series of lectures intended for giving students and graduate students an insight as to what is coming after the college course. I once listened to a lecture at school during my undergraduate work, and I caught one point. It was the only point that I remembered of the whole lecture. I remember this speaker — I have forgotten his name, and who he was — but his advice was, "If you want to learn to plow, ask a farmer." Now you people must learn to plow in some direction. You will have a lot of plowing to do after you get out, and we thought that it would be an excellent idea to ask the man who has plowed and who has made good.

This summer I was fortunate in meeting a very good friend of the Institute, Mr. Aldred of New York, a man himself famous for his developments in hydro-electric work. He is here this morning and will precede the speaker for a few moments. The speaker of the day is a man who needs no introduction to you, Mr. Gerard Swope, president of the General Electric Company, one of our own graduates in the class of '95 and recently elected a member of the corporation, and I am sure that he is looking forward as we are to a very useful contact between him and the institution. I take great pleasure in introducing Mr. J. E. Aldred of New York.

MR. J. E. ALDRED: Gentlemen: We have, with the coöperation of the Faculty of this Institute, arranged a course of lectures to be given by men who have become eminent in their various callings and men of practical experience. It has been said that you can have no great music unless you have a great audience. We can furnish the speakers and we can do some other things, but you will have to furnish the audience if this course of lectures is to be anything like great.

I have always thought in regard to these lectures that they should be called lectures on "Common Sense in Engineering." That "Common Sense in Engineering" does not quite synchronize, as you say, with the professors' title. They prefer to leave the "common sense" out. To them the title sounds a little better without that. But to me the title means nothing unless you retain the "common sense" part of it. Because having had a great deal of experience involving engineering, I have been made to realize that the most uncommon thing is the common sense. But I want to remind you of the fact that this element of common sense is ofttimes the determining factor in the success or failure of an enterprise that may involve engineering, finance and other elements. And I can no better illustrate what I mean than to tell you of a specific instance that came within the scope of my experience.

Some years ago I was called in to take over an enterprise which involved engineering in the development of a large hydro-electric plant, and this company had started seemingly with all the elements of success. It had great financiers, it had great strength in respect to its engineering corps, it had many other essentials. This enterprise went on for a year or more but finally came to a point where, assisted by a convulsion in the market, it failed.

At the invitation of some of those heavily interested, I undertook to make a diagnosis of this situation to see if the patient could be brought back to life. And we found this to be the fact — that while this concern had seemingly most of the things that should have made it a success, it lacked the element of common sense in its management. The first thing done to put that situation right was to call in an engineer who happened to be a man who looked so young that one of the engineers who was passing out of this organization went so far as to tell me that I had sent a boy to do a man's job.

It just so happened, however, that that boy was a Tech boy, and one in whom I had complete confidence. The result was that he carried through this development to a finish, and after completing the work we had about a million dollars left. The element of common, ordinary everyday sense contributed much to this result. Today that company is one of the most prosperous companies of its character in the States.

It just comes to my mind, in connection with that particular piece of work, and it well illustrates how engineering carries on and sometimes may just swing the balance to the wrong side, that there was carried out a very ingenious and elaborate scheme for protecting the fore-bay and keeping ice out of the intake. This work was carried out at an expense of between two hundred thousand dollars and three hundred thousand dollars and helped to break the company. They overlooked the fact that up the river about a mile above the power plant there was a bend in the river bank on the side that the power plant was located, and when the ice came down the first season after the plant came into operation, it forgot to come near this three hundred thousand dollar provision that had been made to take care of it, because this bend in the river shot it all over to the other side.

One of the engineers who had been in this work from the outset, standing on the banks of the river and witnessing what happened, said to me, "It's quite a joke, isn't it?" to which I replied, "Yes, it is if you don't happen to be a stockholder!"

This sort of thing might be duplicated any number of times, but it does not mean that I think engineers are always making mistakes; I know too much about the game for that. But it does mean that you can find numberless instances where work has been done with great care in the drafting room, but they have forgotten to give the proper attention to the conditions under which the plant was to be located and operated.

This morning I looked over a list of the men who are to deliver lectures in this course, and I suppose that we might say of them that they are eminent, distinguished, etc. But it occurred to me, knowing some of these men pretty intimately, that really they were not so distinguished or so eminent; they were just simple human beings. Why I feel that way about these men is that I have been on the inside and

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THE ENGINEER IN SOCIETY

By GERARD SWOPE
President, The General Electric Company

I APPROACH this task this morning with great humility. But when I received the invitation to speak before you I could not resist the temptation, not to speak to you but just to talk with you, because first of all I am a Tech man, and that has always gone through life with me, my great fondness and indebtedness to the Institute, and among the audience here this morning I find old classmates of mine and professors under whom I worked, and it carries me back to those days with the greatest of pleasure.

But I did accept the job with a great deal of humility, particularly when Professor Bush wrote to me and said, "What is the title of your talk?" I had not thought of a title. I am going to illustrate something Mr. Aldred said, that sometimes engineers stumble upon things which are as much luck as common sense, and I suggested the title as "The Engineer in Society; His Relations to Society." It was only when I came to think that Mr. Aldred had given this course of lectures and made it possible that I began to think, "What has Aldred done for Society?" Then I found there was something else besides common sense that made me stumble upon that title, because I think you will agree with me that it was particularly well chosen and through no fault of mine.

There could not be anyone more fitted than Mr. Aldred to have inaugurated this course and to have made it possible for Technology, especially from the standpoint and the view on which I am going to speak of it, because he has really been a pioneer in things which have meant much for mankind.

Up in the woods and wilds of Canada, a wonderful country of pines and rocks, where I had been camping some years ago when it was only a wilderness, there on the river was a large water power, some six hundred thousand horsepower, constantly going to waste. Through Mr. Aldred's vision and leadership and courage, and common sense if you will, he harnessed these water powers. Now, let us see what that has done. That wilderness has been transformed into the habitation of man. These men have reared their families; schools and churches have been erected, and a community has been founded where before only animals played. Constructive industries have been placed there, paper and pulp and of a metallurgical character, which were never before there. But more than that, these industries have not only done things for that particular community where men and women are now living in happiness and contentment, but also they are sending their products out to the world and making it possible for human beings to seek and to find more than they ever had before.

I do not know of any greater contribution of a man to human beings and the community of which he is a part than that kind of a thing. That is really great constructive work. It has taken vision, it has taken imagination, it has taken great courage, and it has taken common sense in the working out of the details.

So that today from a possible source of some six hundred thousand horsepower, approximately three hundred thousand — or half of that — has been harnessed for the useful work of man. That is the work that Mr. Aldred has done. That, it seems to me, is the reason why it is so fitting that he should have inaugurated this course, as he has given to men who can go out in life to do work similar to that, an ideal that is before every man, that makes for inspiration and makes for service to human beings.

As I traveled over the country this spring, as I had to do in the course of my work, I found other instances of that, and I am going to speak of one or two of those instances, not because they are exceptional or alone, but simply because they carry that message to me and I hope they will to you if I can portray it. If I cannot it is the vehicle that is wrong, because I think the idea is there.

I am going now from Canada, around Quebec and Montreal and St. Maurice River, down into southern Arizona. And this is not a big engineering project. It is not nearly so large as those projects I have been speaking of in Canada that Mr. Aldred founded, but it has done something else. And that is the Roosevelt Dam. There it was the courage and vision of the government engineers who made it possible. That was all an arid desert on which nothing could grow. The soil is one of volcanic formation, so that all it needs to be productive is water. Maybe I am saying things that are trite and that you men know pretty well, but I am going to hasten over it and give you a few of the points of it simply to carry the thought.

The rainfall in that region is about six inches per year, insufficient to irrigate and insufficient for anything to grow except the cactus and the sage brush. So they built a dam some two hundred twenty-six feet high, which contains the water gathered from the watershed and the mountains and hills in back of it, to form a a lake of some seventy miles in area which collected this rainfall of about five million acres. This dam lets out the water and irrigates about a million acres. This gives an annual water supply of about thirty-six inches for each of those acres. The line of demarkation between the land that is irrigated and the desert land that is not is as sharply defined as the edge of this table. Where the water has come vegetation of various sorts, alfalfa and other grasses thrive and flowers bloom in great profusion and great beauty, and on this side, just as sharply defined as this line, I say, it is as arid as it was for centuries and centuries before.

Into this valley there have moved hundreds and thousands of people, who are now cultivating the soil. They have erected comfortable homes and are rearing their families in great comparative comfort, because, of course, this water that is coming over the dam, as it goes through the waterwheels, produces electricity so the dam is not only furnishing the water for irrigation for this region, but also producing power for their industries — there are copper mines near there — and also power and light for use on the farms, for use in their homes. So the people that are living in these homes have the comforts that you have in Boston, so far as electric lights and other appliances that you have. The people working on the farms have more appliances than the people who are working on the farms in New England. It is simply because this cheap power has been created. The amount of money that these works cost was not very great, some millions of dollars, twenty I think, that was defrayed by the government. The people who are using this water now are paying so much per year per acre-foot of water, which is sufficient to pay for the cost of the management of the enterprise plus the interest and amortization of the bonds, so that after a certain period the entire bonded indebtedness and the money that the Government has put into it will be paid back.

But furthermore — and this is really quite instructive — the Water Users' Association of that territory have their own management and their own engineers. The Government has put it in their hands, but they have seen the possibilities of it, and now sixty-five

miles below they are building another dam so as to accumulate the waters between the first dam and the second, very much as they do in the different water supplies on the St. Maurice River or any great power development. Here, of course, they are planning primarily for irrigation and not for power, so they are getting this water from this watershed some sixty-five miles between, where, of course, they can have a greater area and supply a greater number of people.

Now what this has done, it seems to me, is this: first, it has made a part of the earth's surface habitable which was never before habitable. It has made it useful for the purposes of man, which it never was before. And, second, the products of that territory are now going for the use of mankind in other states, and it has produced those products at a lower cost, making a wider distribution than ever before. That, it seems to me, is another type of a great constructive enterprise, one that has brought happiness and comfort and a greater amount of well-being not only to the people who are doing that work but to the people whose needs this enterprise is serving.

From there I am going to turn just for a moment to the Northwest — and I am just taking these various illustrations, not that they are at all comprehensive, not that they are at all typical, but simply because they have come in my horizon as I have traveled around. Up in the Northwest, in Portland, where they are handling these great big logging operations, I went to a paper and pulp mill of the character that Mr. Aldred has made on the St. Maurice River, where great big logs come in and are handled mechanically by machinery; no human hands touch them, and could do little if they did, they are so huge. I talked to a gentleman who had been fifty years in paper and pulp mills, first in the East and then out there, going there as a pioneer in the development of the business. He told me this story, which seems to me worth while telling here, for it is filled with much of import to us. I am not going to speak of the process of paper-making; I assume that you know that, or at all events, you know the last process, in which the pulp, dissolved in water, passes in a thin film between the rollers and the water is squeezed out so that you finally have the paper fibres adhering to one another and forming the finished paper. The essential thing is that these rollers should run strictly in synchronizing so as not to put any great strain on this weak fibre of paper as it is running through them. This man told me that they formerly ran their machines at about fifty feet a minute. He says he remembers the time when the superintendent suggested that they run it sixty feet a minute. That was a revolution in the shop; it had never been done; they couldn't do it; things would break down; you never could make paper that way. But to make the story short, it was done, and done successfully. But the interesting thing is that today they are running a thousand feet a minute with a synchronized electric motor. That produces better paper, and twenty times as fast.

The point I want to leave with you is this: by this increased production, twenty times as great, a thousand feet a minute against fifty, you have done several things. You of course have cheapened the cost of your paper. Now cheapening the cost of paper has a tremendous significance, especially in a country like our own, where its democracy, if it is to be successful at all, must be founded upon education and the elimination of illiteracy among its people. Therefore you have made the production of the paper upon which your textbooks and your newspapers and your magazines are founded much cheaper, and therefore they can have a much greater spread and reach a larger number of people.

It seems to me that is the constant test of progress in civilization: does it finally, and to an ever-widening circle, reach a larger and larger number of people in the body politic or in the community of which we are all a part? It seems to me that progress in civilization means largely that — that a larger number of people are constantly participating in its benefits. The test of a civilization must be that — that is, the happiness, contentment and well-being of its people. If it is not that, it is not making the contribution to human beings that they can rightfully ask that a civilization shall do.

Now those are a few typical examples. After I happened to think of them and thought I would speak of them to you, then I thought I would look and see what the definition of an engineer was. That seemed to be a commonsense way of approaching this subject. So I looked in the dictionary. Maybe my dictionary was out of date. It says: "An engineer is one who manages a stationary or a locomotive engine." That is all it said. There wasn't any other definition; there wasn't any other thought. Below that it said: "Engineering — is the art of managing engines; especially the art and science by which the mechanical properties of matter are utilized in the construction of machines." And that is all of engineering.

Now of course, to your mind and to my mind, both engineer and engineering have a very much broader significance than that. First you have got to approach any problem and analyze that problem. What are its elements? An engineer's training is just exactly that. You use your mathematical analysis to break down your proposition into its simplest elements and see what those elements consist of. There is no more exact method than mathematical analysis. It is accurate; you can depend upon it when you have got it. That is one fine thing in engineering, that its basis is a thing you can depend upon.

Now after you have got that analysis you have got to apply common sense in the interpretation. Now that is where it seems to me this common sense, which is common and still so uncommon, as Mr. Aldred has said, comes in. Because you have got to weigh those things. It is your sense of value; it is the sense of proportion that you have to place upon these various elements that your analysis produces. I mean, you can have an analysis of a problem presented to six different men and the six different men may see it from six different points of view and not any one of them, possibly, get a comprehensive view of the relation that these elements bear to each other which it seems to me quite essential that we grasp before we can proceed to a comprehensive solution that the problem involves.

Now after you have got that you have got to have another thing — and this I have found, too, in my own experience, as you also have found or will find — that after you have your analysis and after you have made up your own mind as to what the answer is, the proper balance of these elements, you have got to have the courage to make a decision. It is perfectly remarkable in life how many people like to "pass the buck"; how often they would rather have the other man make the decision. I have seen that in the army as I was on the general staff of the War Department in 1918. I have seen that in all walks of life. People often feel that if they have some one else make the decision they are relieved of it and so avoid mistakes. In other words, you have got to have courage in making a decision. It is not so much a conscious courage as it is faith that you have made this analysis correctly, that you have placed the proper valuation and relations of these elements and then say, "Yes, that is the result of my analysis and I am going to go ahead along that line," and then go ahead.

To my mind there is no better basis for human work than study along engineering lines, because it has trained people in exact analysis. Now if you will give to that engineer also, it seems to me, a cultural training, so that he has something of the history of the de-

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THE DEVELOPMENT OF A WATER POWER PROJECT

By JULIAN C. SMITH, M.E., LL.D.
Vice President and General Manager, Shawinigan Water and Power Company

IN this lecture I shall attempt to describe the development of a waterpower including the company organization, and the financial operation which provided the money to carry on the work.

I shall try to avoid technicalities, but I shall assume I am addressing students of engineering who understand without explanation the phraseology required to describe engineering structures.

I desire also to leave the impression in your minds that a properly designed well-built waterpower which has been conservatively financed must be the work of men highly trained in this branch of engineering and finance.

You are learning the science of engineering here, and you must have that to proceed. You cannot get out of textbooks the "Art of Engineering," by that I mean the application of common sense — courage or restraint, as conditions may warrant. Only natural endowment or more likely "bitter experience" will develop these characteristics. However, I have no intention of preaching a sermon on this subject, but will only advise those of you who go into waterpower engineering to look forward to some years of apprenticeship after graduation.

Usually the idea of developing a particular waterpower has been in someone's mind for a long time before conditions warrant any action. Finally, the promoter of the enterprise, who may be the owner, or acting for the owner, decides that the power should be developed.

For the purpose of this lecture, I shall assume the decision is wise, and no obstacles block the procedure, but you must understand that in a large percentage of cases delays occur which sometimes take years to overcome.

The preliminary work consists usually of surveys which are sufficient to map out the power development between the upper and lower limits of its effect on the river. The rights for development are secured from the Government, Provincial, State or Federal, and lands are purchased or optioned covering the site of the power house and the dam, as well as all lands overflowed by the raised level of the water.

Having proceeded this far in the field, a company is formed to which the property and rights are sold. The waterpower company then takes up the work. Money is essential, engineering work must be done, and business management must guide the enterprise. So the company formation is divided into the executive, represented by the president, vice-president and general manager; the engineering represented by the chief engineer, the consulting engineer and their associates; and the financial, represented by a vice-president, treasurer and assistants.

The company I am describing will have a simple financial structure. Its capital stock has been sold to pay for the rights, property and preliminary expense. To get funds to build the dam, power houses and other necessary works, bonds are issued. I have here such a waterpower bond. The total issue constitutes a first mortgage on all the real property of the company, including rights, franchises and including not only the existing property, but also any property which in the future comes into the possession of the Company. Such a bond (a thirty-year 6½% gold bond) means that 6½% interest is paid (in this case on April 1 and Nov. 1, 3¼% is payable) on presentation of the coupon which is detached from the bond, and which is paid on presenting it at the bank or trust company named in the deed of trust.

The deed of trust is an agreement between the company and a trustee who acts for another on behalf of the bondholders. This deed of trust is not only a mortgage in the ordinary sense of the word, pledging the property in case of default of payment of interest, but also contains various other conditions and agreements intended to protect the bondholder. For example, in case the bonds sold are part of a larger issue, there is a provision that future bonds will not be sold except to provide eighty per cent of the money required for extensions; the other twenty per cent must come from some other source.

There is usually a condition that future bonds after the company is operating cannot be issued unless the company's net income is one and one-half times or twice the amount necessary to pay all bond interest, including the new issue.

There are provisions about insurance and proper maintenance and a multitude of other necessary things, including directions of how the trustee shall proceed in case of default on interest payment. The bonds are called thirty-year because they mature in thirty years, and must be redeemed at that time, *i. e.*, thirty years from the date of issue. They are called gold bonds because they are redeemable in gold coin of the United States, Canada or Great Britain, as the case may be, and large issues are frequently made redeemable in either London or New York. The interest is usually payable in United States funds in New York or in sterling in London, or in the case of Canadian issues in Canadian Funds in Montreal.

The capital stock of the company is represented by shares of common stock. I have one here, and you will notice that it is simply a certificate that someone is the owner of so many shares of stock.

Now all these problems of finance, legal difficulties and approval by various government authorities must be pretty well solved before work is commenced.

Up to the time of the formation of the company probably the engineering work consisted of preliminary surveys, accumulation of data and reports from consulting engineers. These reports were for the purpose of giving information to base financing on, and included estimates of probable cost. Just here is the reason why such reports contain underestimates.

(a) They are made for the purpose of obtaining money, and they paint as rosy a picture as possible. In these circumstances even the most able and honest engineers are apt to underestimate, for it is a human characteristic to think as we hope, and most of these early reports are based on too little study and information; rarely is such a report based on actual detailed design.

Taking all the reports and data available, the chief engineer of the company now finds it is his duty to locate, design and build the power plant. He is usually handicapped by finding out that the financing has been done, and that he must complete the job inside a certain amount of money, an amount which he may or may not have assisted in establishing.

The real survey work now begins. The site of the work is usually tied in to some adjacent government bench mark. A main base line is run and monumented, then a detailed topographical survey of the whole area is made with contours every few feet at places where structures are probable, and ten feet apart the rest of the area.

Having proceeded thus far, a geographical study of the site should be

made. This study need be brief, if no abnormal conditions are met. The investigation should show that the dam and power plant are located on continuing geological conditions, that is, the area chosen should not be at a point where geological conditions are changing. Faults either minor or extensive, changes in the rock foundation, and even changes in the overlying material are to be avoided in choosing the location of the power plant and dam.

At this stage of the procedure, the rock borings which may have been taken to some degree will be completed and complete knowledge of the underlying strata obtained. In good rock, these borings are made about twenty to thirty feet deep. In poor rock borings may go down from fifty to seventy-five feet. The object of the borings is to determine whether the rock beneath will carry the weight of the structures, and whether when the added water pressure occurs, the rock will be tight.

Let us leave this kind of work for the moment, and describe another branch of engineering which must be carried on.

The study of the water records can be carried out when these records are reliable and extend over several years. This is true in many cases and the engineer has the advantage in these cases of comparing results. These water records consist of flow records, giving the flow of the stream day by day. It has been said that this record should extend for twenty-five years to be of real use. Not many streams have been recorded for that time, and records from ten to fifteen years duration are considered of great value.

The problems of the water, of course, are these:

What is the maximum flow?

What is the minimum flow?

What is duration of both maximum and minimum?

What is flow of river at all times, between maximum and minimum?

What storage facilities are available?

What is the area of the watershed?

What is the rainfall per annum over a long term of years?

What is the runoff?

I do not propose to discuss these points, as they are highly technical, and you have had instruction in your studies on most of them.

I wish to touch briefly on the storage of water. It is of course energy storage that we are looking for. Now energy may be stored in several ways — as chemical energy in a storage battery, or by manufacturing hydrogen or calcium carbide. By compression of gases: by changing the "state" of solids to liquids — liquids to gases. By mechanical means such as the momentum of a flywheel. None of these methods can approach the storage of water in meeting the conditions required of length of time, large amounts of energy stored, and the ease of conversion when required. This one field of waterpower work, the conversion and storage of water, is, in my opinion, one of the most important and fertile fields for cultivation.

The chief engineer of our company gets all this work on records, gaging, etc., well started, and then turns his attention once more to the site of the development. His surveys now show him the extent of the lands which will be flooded — whether there will be any interference with other waterpowers above or below, and if additional lands must be acquired. The presence of islands in the river often determines the exact location of a power plant. Sometimes islands are good things to anchor foundations on and are of assistance in laying out the construction plant. Sometimes, on the contrary, they are in the way of what otherwise might be a straight headrace or tailrace. When unwatering operations are necessary, islands are of assistance, as a rule, to work from and as a start or end for cofferdams.

The exact design of the plant can now be proceeded with. A knowledge of the probable load gives a load factor which may or may not be reached, depending on the storage facilities at or near the plant. You understand, of course, that the load in a waterpower is not steady, but varies over the twenty-four hours. The ratio of the daily maximum to the daily average is called the daily load factor.

The total capacity of the plant now arrived at, the number of units may now be chosen as five or six.

A study of waterwheel characteristics now determines whether this is possible. In a large, low headplant, it may be necessary to increase the number of units to ten or twelve. It is not wise to install the largest possible units, even if they are otherwise suitable. Most of the largest units are pioneer designs, and a safe rule to follow is to stick to well tried-out designs unless the conditions really force the adoption of special designs. Having chosen then the size which will give five or six units, the rest of the design rapidly works out. In low and moderate headplants up to about three hundred feet head, the vertical turbine will be chosen. This turbine is the single-runner design, equipped with a thrust bearing on top of the generator, and generally following the design now used in many plants.

There has been a great deal of dispute regarding this. The great waterwheel makers of the United States and Canada favor a design in which the draft tube is a straight tapered tube and the bottom of which is immersed in a pit open to the tailrace. Various devices are used to increase the efficiency of these draft tubes, and your textbooks will show the so-called Moody draft tube, with a cone running up the centre and the "White" hydro-cone type. There still seem to be uncertainties in all designs of draft tubes and work is now going on in various testing flumes to establish beyond a doubt the best types. Probably there is no best type for all conditions, and the chief engineer of our enterprise must use his experience and judgment in making a choice.

If the plant is a large one and the arrangement or the size or the speed of the unit departs from standard practice, then it is desirable to construct models of the arrangement of the turbine runner and test these models to see whether the performance will be as planned.

The use of models in connection with the design of hydraulic stations and water turbines has increased very materially during the last several years and a number of hydraulic testing flumes have been established in various parts of the country for this purpose.

For a great many years the Holyoke Testing Flume has been used and has done valuable work in demonstrating the performance of the turbine runner.

In addition to the main units themselves, there must be installed a number of pieces of machinery which are accessory to the main units.

These accessories include governors, governor pumps, oiling system, air compressors, and in some cases, exciter turbines.

The direct current to supply the fields of the main units is driven either from the direct current exciters mounted on the top of the vertical generators or from independently driven direct current machines. These smaller machines may be driven either by water turbines or by electric motors, operated from the main units.

In the case of large plants, there are installed a number of small turbines operating alternating current generators. These alternating current generators in turn drive induction motors to which are connected direct current generators.

The reason for the use of alternating current in the case of these large plants was due to the fact that large amounts of power had to be used for the operation of the governor pumps and other auxiliaries and it was felt that an independent alternating current system was the solution of the problem. The auxiliary equipment, including the

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JULIAN C. SMITH

THE second lecture of the Aldred Series was given on November 23, 1923, by Mr. Julian C. Smith, vice-president and general manager of the Shawinigan Water and Power Company. This company is one of the largest, if not the largest, power company in Canada. It has had a remarkable growth. It was incorporated in 1898 and started building its first power plant in the fall of that year. This development was successfully completed and the plant was put into operation in 1902. From this date, there has been a continued expansion in the amount of power produced, number of power plants and in the size and length of the transmission systems. At the present time, the Shawinigan Company is not only a power-producing and transmitting company but also a holding company of many subsidiaries. The Shawinigan Company can supply 330,000 h.p. This is partly developed by its own plants and partly by its subsidiaries. It delivers power over some 1,500 miles of transmission lines to about 100 communities. It is the source of electric energy in a community of about 20,000 square miles and containing a population of about two and a half millions of people. In the first lecture, Mr. Gerard Swope cited this company as being an example of the contribution of engineering to society. As he judged service as being the important requisite of such a contribution, he could not have selected a better example than the Shawinigan Water and Power Company. The company is continually expanding and at the present time has under construction a new plant of 150,000 h.p. The financial structure of the company has been increased from a small beginning until now it represents some forty millions of dollars of capitalization.

Mr. Julian C. Smith started with the Shawinigan Company four years after its incorporation. In 1900 he graduated from Cornell University in Mechanical Engineering. He worked for Mr. Wallace C. Johnson, a consulting engineer in Niagara Falls, for two years, and in 1902 started with the company of which he is now general manager. Mr. Smith mentioned in his lecture the necessity of serving a period of apprenticeship in water power engineering. He himself had several years of this apprenticeship and considers it as one of the most valuable parts of his training. Since 1902, his engineering work has been closely connected with the Shawinigan Company, and for many years he has had complete charge of their engineering work. Mr. Smith has been connected with most of the larger water power developments in Canada for the last ten years. He was hydraulic engineer in charge of the design and construction of the Cedar Rapids Plants, one of the largest power developments on the St. Lawrence River. He was the designer and superintended the construction of the Number 2 Plant of the Shawinigan Company at Shawinigan Falls. For several years he was consulting engineer for the Lawrentide Power Company in connection with their power development. He had charge of the construction and acted in a consulting

JULIAN C. SMITH

capacity in connection with the design of the great storage dam at LaFoutre. He has been supervising engineer for the Manitoba Power Company. For the last two years, he has had full charge of the design in connection with their new power development. At the present time, along with his other work, he is president of the St. Maurice Power Company whose plant he designed and built some years ago. Each of these projects represents an achievement partly because of their size, which is 100,000 h. p. or more in each case and partly because they have been very successful enterprises. Mr. Smith was made a Fellow of the A. I. E. E. some years ago and is also a member of the A. S. C. E. He received an LL.D. degree from Queens University in 1923. He has written extensively on subjects related to water powers and transmission lines.

Industrial Positions for Every Trained College Man. Spurred by the fact that the need of big business in the United States for trained young men to become leaders is far surpassing the ability of the nation's technical schools to graduate men of this caliber, a committee of eminent industrialists and educators is holding a series of conferences in New York to seek a remedy for the difficulty. They are confronted by the little-understood necessity of filling, by 1930, at least 200,000 new positions of responsibility in industry; whereas there are available in the technical schools at present only about 50,000 students. Enrolment in these schools in 1920, when the first of the graduates aiming to be the future leaders in industry took up study, was 51,908, and today the enrolment is only 52,290.

In a report just made public, the committee says: "What is likely to be the situation in 1930? American industry may need 400,000 more persons for positions of responsibility in 1930 than it used in 1920. This is in addition to the replacements necessary. The reason for this growth in demand for experts and leaders is the change of methods by which industrial work is being performed which change consists mainly in the development of corporations, in the increasing use of machinery, power and other labor-saving devices and in the elaboration of methods of control in production and distribution. Mass production greatly increases the amount of product per worker, but requires a relatively larger increase in the proportion of planners and administrators.

"These facts and figures demonstrate that both the normal progress in industrial methods and the approaching new competitive conditions will call for a more decided change than ever before in the quality and number of trained experts and leaders."

A survey of the educational facilities of the country for meeting this great and hitherto unheralded need shows, the committee finds, that they are limited. At present the technical schools of the United States are turning out about nine thousand graduates a year and, in industry at present, less than twenty per cent of those who now plan and adminster the productive work of the nation are graduates of any college at all.

Woman Pilot Loops Ninety-Eight Times. Mme. Adrienne Boland, French woman aviator, established a record by looping the loop ninety-eight times within a period of fifty-eight minutes, this including the time necessary for ascending and descending. A leak in the gasoline tank of the plane prevented her continuing.

JOHN WILLIAM LIEB, JR.

THE third of the Aldred Lectures will be given on December 7, 1923, by John William Lieb, Jr. The Aldred Lectures are planned with the idea of covering the different branches of engineering. The first lecturer was the president of a big manufacturing company; the second, a pioneer in water power development; while the third is the most prominent central station engineer in the country.

J. W. Lieb, Jr. was born in Newark, N. J., on February 12, 1860. His early education was acquired at the Newark Academy and at the Stevens High School, Hoboken, N. J. In 1880 he graduated from the Stevens Institute of Technology, receiving the degree of Mechanical Engineer. Immediately after his graduation he entered the employ of the Brush Electric Company of Cleveland, Ohio, as a draughtsman. He remained there less than a year, entering the employ of the Edison Electric Light Company of New York, in a similar capacity. In 1882, he was transferred from this company to the experimental department of the Edison Machine Works. He assisted in the tests of the first "Jumbo" direct-connected Edison dynamos, and was put in charge of the installation of the electrical equipment of the old Pearl Street Station by Mr. Edison, Mr. C. L. Clark being chief engineer at the time. Mr. Lieb assisted in the tests and experiments incident to the starting up of this pioneer station, the first commercial station in the United States to supply current for incandescent lighting and power from an underground system and on the inauguration of regular service, September 4, 1882, under the auspices of the Edison Electric Illuminating Company of New York, was appointed its chief electrician.

A syndicate of Italian capitalists, with Professor Colombo as technical adviser, having purchased the complete equipment of boilers, engines, dynamos and Edison underground systems for Milan, Italy, Mr. Lieb was selected by Mr. Edison to direct the installation. The Milan station, equipped with B & W boilers, Armington and Sims engines and Edison "Jumbo" dynamos, began regular service in 1883 and Mr. Lieb remained in charge as manager on the organization of the Italian Edison Company. He was appointed in turn its chief electrician, director of stations and chief engineer in general charge of the technical department of the company, engaged in manufacturing electrical apparatus, installing isolated plants and constructing and operating lighting and power stations throughout Italy.

Mr. Lieb's company was among the very first to exploit the alternating current system, beginning with a plant in Milan, Italy, in 1886, and using the Thomson-Houston arc light system extensively. His last work in Italy was in the electric railway field in connection with the installation of the trolley system in the city of Milan.

Offered an appointment with his old company, the Edison Electric Illuminating Company of New York, he returned to New York in 1894, at first in the capacity of assistant to the vice-president, and advancing by steps to third vice-president and general manager. On the consolidation of various

JOHN WILLIAM LIEB, JR.

lighting interests in New York City, under the corporate name of the New York Edison Company, Mr. Lieb was appointed third vice-president and associate general manager. He also served as president of the electrical testing laboratories and director in several electrical corporations.

While in Italy, Mr. Lieb was decorated by the King of Italy, being made a Knight Commander of the Order of the Crown of Italy. In 1904 Mr. Lieb was president of the American Institute of Electrical Engineers. He is a member of the American Society of Mechanical Engineers, a member of the American Society of Civil Engineers, past president of the Association of Edison Illuminating Companies and the New York Electrical Society, past vice-president of the National Electric Light Association. Other societies of which he is a member are Edison Pioneers, Illuminating Engineering Society, American Association for the Advancement of Science, Franklin Institute, Municipal Art Society, American Museum of Natural History. He is a member of the Delta Tau Delta Fraternity and of many clubs in New York.

At present he is vice-president of the New York Edison Company and is considered the foremost central station engineer in this country.

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found out some of the tricks of the game, and I can assure you that if those so-called eminent engineers and illustrious gentlemen had to put their hand on the Bible and tell the truth, they would have to confess that in attaining to the heights they have reached, they have just used ordinary simple methods of common sense and reason. It may have taken various forms, one man's idea of common sense may have been to work a little harder than the other fellow. In another case, it may have meant that when he saw a chance he took it and stayed right there until he worked it out. It may have taken one of many forms, but back of the wonderful intelligence these gentlemen display and all this camouflage of technical knowledge and everything of that sort, if they had to confess, they would tell you that it was really the ordinary elements of sense and reason to which they attribute their success.

Now, I think that this is a matter of importance, and if you think it needs checking up, I will ask you to just keep your eye on these gentlemen as they deliver their lectures and analyze carefully what they say, and I think you will find that in the background is this element of reason and sense, perhaps coupled with this other element which I think is of great importance, and that is the element of stick-to-itiveness.

Now this is just a phrase, if you like, but let me tell you, the difference between success and failure is very, very small; the margin is very narrow, and the mistake that the engineer makes in spending two hundred thousand dollars or three hundred thousand dollars on something that is of no use may just tip the scales over and make a failure of what would otherwise be a success.

I dare say, if these men who are going to speak to you, all of whom have been successful in their lines, had

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velopment of a people, of its civilization, of its tendencies — so that he can look upon these movements as they arise with some tolerance and also with sympathy, because one needs sympathy in life — then it seems to me that the engineer is the best fitted of any profession or any student to grapple with the problem of life.

And that leads me to my next thought, in which I think the engineers have done least of all in the development and the solution of the problem before our social fabric, and that is the industrial problem. And that is one that I have very near to my heart. A comparatively new situation is the factory development of industry, where you have a large aggregation of capital in the form of a corporation and large numbers of people employed in the service of that corporation, and the question of management arising. It is not really a question between capital and labor, it is largely a question between management and labor. I am as much an employee of the General Electric Company as the janitor or the porter. I don't control the corporation. I am free to confess. I am a stockholder in it, but a very small stockholder. There are many, many larger. These aggregations have become so large, no corporation is now — or I would say maybe that is too sweeping, because Henry Ford is an example of it — but very few corporations are owned or controlled by one or two men. They are usually owned and controlled by thousands and thousands of stockholders in all parts of the country, and often a large part of the stock held by the workers themselves. So that the problem in industry is not a problem, as it seems to me, between labor and capital, but between management and labor, where management is also as much of an employee as the laborer himself.

Now it is a question of approaching that problem, as I said, with justice and with sympathy to find the right solution. And there, as I say, the engineer has taken but little part. He has been very largely an academic adviser. He has not gotten into the hurly-burly of the work to find the right solution, or how that problem should be handled to work out the best results. It is an engineering problem. Here you have got thousands of men engaged on work that is worth while doing for the community, that should win their respect, constructive in every way, and the character of it is one that should appeal to their imagination; and still largely we regard it as a task to be performed. We eliminate from it all the individuality and the personality that must go with it if they are to retain their self-respect and have ours. It seems to me an engineer can introduce into that problem a tendency to a correct solution which is something that is needed very much indeed.

And there is another point of that. I think it is largely an indication of the civilization of a country in regard to the wages that it is paying to its workingmen. There is nothing inconsistent between high wages and low costs, because what you have got to see to is that your high wages are more largely productive. Now that is largely an engineering question — engineering and management; first, engineering in a constant search for truth and for better methods of production, introduction of automatic machinery, introduction of labor-saving devices, because it is a constructive thing in the interest of society to eliminate human labor and to replace it by machinery; and labor will admit that. Of course it sometimes works a hardship in those transition stages upon the labor immediately engaged, but as far as labor themselves and society as a whole is concerned, there is no doubt that if you can reduce human effort by the introduction of machinery you have made another milestone in the progress of human beings and of the community as a whole. So that it is not at all inconsistent, as I say, that you should have low costs and high earning power on the part of your men. But it does mean on the part of engineers an increased responsibility to find constantly better ways of doing things.

I am going to illustrate that by some work that has been done — this may not be a personal reference, but it is a reference to the General Electric Company, because they have been pioneers in this to a very large extent — and that is in the incandescent lamp. The primary inventions of the incandescent lamp have been associated particularly with three men, two of whom are Tech men — Dr. Willis R. Whitney of the class of 1890 and William D. Coolidge of the class of 1896 — and there is another man, Dr. Langmuir, also of the General Electric Company. Those three men have been part of the brilliant staff of the laboratory of the Company. They constantly set themselves the job of finding a better source for light which will furnish a better light and at less energy and therefore at less cost to the community, so that a larger class of people might enjoy its benefits And they have solved that problem and the patents have been recognized in the courts of the United States and in the courts of other countries, so that they are now the basis of the art throughout the world today. That is very high scientific work of the best character. Dr. Langmuir's work in pure science is world-acclaimed. But that is beyond most of us. Common sense does not touch that. That is brilliancy, that is genius. It is given to but few people to accomplish that kind of thing. But the thing that has been done subsequent to that is the application of engineering methods to the problem that was then left, and that is the problem of working out those methods to best advantage. And that has been accomplished by the introduction of automatic machinery, and this is the interesting thing: Almost within the last year that industry has been revolutionized, and now we are on the way to getting a much greater output per operator with less effort, a much greater output per square foot of floor space, and a much greater output in number of lamps per thousand dollars of capital invested. From every point of view it is a great constructive forward step in having introduced better methods, more automatic machinery, decreasing the labor content and therefore decreasing the cost by increasing the output for a given amount of effort.

Now see what that means. That is the application, as I say, of pure engineering, of pure common sense, to the problem that any engineer can do, or several engineers. This has not been done by any one man; this has been done by a group of men working to solve that general problem. I speak of that in the lamp field because it is typical. That thing is going on in all industries. It is going on in the production of motor cars, in the production of generators, in the production of motors, dynamos and everything else. Wherever engineers are applying their minds to the problem of doing better work, where they are showing that decreased cost of production is not incompatible with increase of wages to labor, they are helping in the general progress of humanity. When this problem is solved of establishing better relations between labor and management, and the men find greater pleasure in the work they do, and receive remuneration commensurate with the service they are rendering, the engineer will have performed his greatest service. This service to the community, this broad service to society, it seems to me the engineer's training has fitted him for better than any other profession, as I said before. This tremendous field lies before you,

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pumps, etc., is generally grouped together at one end or in the centre of the power plant.

The electrical design of such a station in its early stages consists of the determination of the safety of the main unit which is intimately related to the question of head, the size of the unit, and the efficiency of the unit at full gate and part gate. While in general the speed of the unit is fixed by considerations connected with the hydraulic design, the exact speed is fixed by determining how many poles the generator must have.

Alternator current generator designers have a preference for a certain arrangement of windings and there are some combinations which work out better than others; therefore, the choice of speeds is usually not a question of simply the addition of one pair of poles to obtain the nearest speed desired, but one must take into consideration the question of the electrical design of the generator, and find out whether the speed chosen conforms with the electrical design.

The size of the generator is determined first, by the size of the waterwheel and the amount of power desired, second, by the power factor of the system, and third, by the temperature requirements of the power company.

As the designs of these machines have become better worked out, it has become common practice nowadays to make a generator relatively larger than the waterwheel so that the danger of overload under normal conditions is reduced. In many stations the water turbines can be opened up to full gate without overloading to any serious extent the electrical equipment.

The question of power factor is an important one, and is becoming more important as systems are extended and long transmission lines are becoming more common.

I do not desire in this paper to go into the details of electrical design, partly because it is a highly technical matter and therefore of interest to fewer men, and partly because these questions are usually handled by the large electrical manufacturing companies, and the advice which they give on these matters determines to a considerable extent the design of these factors.

The dam which holds back the water in the river must be designed in accordance with the theory which you have learned in your textbooks. The type of dam is largely a question of choice and depends upon the local conditions. The dam design will be either of the gravity overflow type possibly provided on the top with some kind of gates or stoplogs, or else it will be of the non-overflow type, and a section of the dam will be wholly devoted to large stony sluice gates or some other type of moveable dam.

Where it is desirable to hold the water level as nearly constant as possible, the regulation is done by some type of a gate. In many cases differences of water level of a few feet are of no importance and the overflow type of dam can be installed more economically and with less cost of maintenance than the movable gates.

In case of the gravity dam, the size and weight of the dam will depend upon the usual factors of height of water, etc., also upon the question of whether the ice pressure is a factor in the design. Most dams built in northern climates have considerable increased mass due to ice pressure, which is assumed to act at or near the crest of the dam.

These forces are sometimes assumed to be very large, up to fifty thousand pounds per lineal foot, and the effect on the design of the dam is to increase the mass to a considerable extent.

I mention this point because at the end of the paper I desire briefly to discuss some possible improvements in the design and I will refer to this question of ice pressure.

Some weeks ago I had occasion to prepare a table showing approximately how the different items that go to make up the construction of a waterpower development are proportioned as regards the expense. This table is as follows:

Preliminary work, including expenses engineering reports, legal advice, etc.	2%
Lands, etc.	7%
Discount on bonds	9%
Interest during construction	9%
Legal	1%
Engineering and superintendence	5%
Head office expense	2%
Insurance	1%
Construction buildings and camps	2%
Construction plant	9%
Cofferdams and tracks	7%
Dams	13%
Power House	13%
Machinery	19%
Operators' houses, roads, misc., etc.	2%
	100%

In looking over this table you will note that about thirty-three per cent is made up of items not connected with direct expenditures in the field, and about twenty per cent is made up of temporary equipment, cofferdams, tracks, etc., which might be called preliminary work, and that only about forty-seven per cent represents the money that goes into the permanent work. The other expenditures are necessary, however, and must be made before or during construction.

I wish to bring to your attention the probable future developments that may take place in waterpower engineering in its broadest sense.

We must all recognize that so far as machinery and questions of efficiency are concerned, there is little left in the way of possible improvements. Modern waterwheels operating under good conditions, develop over ninety per cent of theoretical power. Always some power must be wasted in order to carry away the water from the waterwheel. The possible gain here is a matter of not over four per cent or five per cent at the very best. The generators have efficiencies ranging from ninety-five per cent to ninety-seven per cent, and it is more a question of the amount of money that one wishes to spend in the design and construction of the generator than any other factor that determines the maximum efficiency. I believe generators can be built that would have efficiencies of ninety-eight per cent if one were prepared to pay the price. Even the general arrangement of the waterwheels and generators, and the design of the power house substructures has in the last few years become more or less standardized. I do not mean that there are no possible improvements in this arrangement. Every new plant has its own local conditions which must be met, and there is no rule that can be universally applied in these cases. However, practically all possible schemes have been tried out in the different developments, some good, some fair and some bad, and the new developments are based upon the designs and experience which have preceded, with the result that speaking in general terms there does not seem to be great improvement probable in the power house substructure designs. By great improvement, I mean the possibility of either reducing the cost or increasing the efficiency, or both.

There is one possible development which will reduce to some extent the cost of waterpower development and which will make possible the development of a lot of powers, which now cannot be developed by reason of the excessive cost.

If the speed of the units can be increased for a given head, or if the speed of the water through the passages can be increased so that the passages might be made smaller, then the

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overall cost of the power house and machinery will be reduced.

The waterwheel companies in the United States and Europe are bringing forward now new designs for waterwheels which operate at much higher speeds than the so-called Francis turbines, which have been standard for the last fifty years.

The speeds of some of these new designs are substantially double the speeds of the Francis turbines under the same head for the same power. The cost of the electrical equipment is much reduced when operating at higher speeds, and the moving parts being lighter require cheaper cranes and other appurtenances in the power plant.

There is, therefore, the possibility that new plants built with high speed units can be built for somewhat less money than the present designs.

In examining the table the items of machinery represent eighteen per cent of the total cost. This item is therefore susceptible to some reduction. This item is probably made up of about seven per cent for hydraulic machinery and eleven per cent for electrical machinery. The hydraulic machinery would perhaps not be changed in cost very much, but it is conceivable that by doubling the speed, the cost of the electrical machinery might be reduced by twenty-five per cent. If this could be done, the total cost of the development would be reduced by something like two per cent or three per cent, which would be a very substantial saving.

It is of the utmost importance that the engineers who carry out the design of the waterpower plants make their designs with care, as the following will show.

A gravity type dam may be designed as you know to take care of the water pressure, and that design is pretty well standardized. The first question that one must decide in this matter is, what assumptions are to made be as regards the upward pressure of the water, and the second question that must be decided in the northern climates is, what pressure, if any, will be assumed to represent the ice thrust. I will show you some cross sections which illustrate how much difference these assumptions make in the size and cost of the dam. One cannot decide these matters offhand, and every plant must be studied carefully before a decision on such a matter can be arrived at.

The cost of the plant is, of course, affected materially by decisions as regards these and other assumptions of a similar nature, and this is one of the means by which the cost of the plan can be reduced, that is by wise decisions which will carry the safety and efficiency of the plant to the proper point, without calling for expenditures of money for things which do no good.

After the power house is completed the operating staff must be organized and this staff will consist of an operating superintendent, one or two shift operators who will probably be on duty eight hours each per day, and two or three floormen who will look after the pumps, switches and other auxiliary equipment as well as keep the main units oiled and cleaned. In addition to these men there will be one or two men whose job is to keep the power house cleaned up and a small staff of electricians and mechanics, probably three or four men in all, who will be required to keep the plant in repair and to do various odd jobs which are always coming up in connection with such a power station.

The whole operating staff of such a plant as we have described should not exceed twenty men and the number of men employed per horse power developed, in the event that this station is of the order of one hundred thousand horse power, is as you see very small.

In order to take care of the operating staff, houses are built, roads are provided, and railway connection is usually made which extends clear into the power house, so that machinery can be handled in and out without trouble.

I have described briefly the organization, the design, and construction of a water power plant and I have tried to impress upon you the fact that a great number of considerations influence the different factors in the design. In choosing one or other, the engineers in charge of the work must not only use the technical and theoretical considerations involved but also must give careful consideration to commercial and practical considerations. For example, it is always possible to increase the efficiency of a waterpower station by the expenditure of additional amounts of money. Just where these expenditures should stop is a matter that must be determined by the engineers. Usually speaking, the tendency of engineers is to push the expenditures too far and to try to obtain too high efficiencies. Very frequently slight reductions in over-all efficiency mean a great saving in the total expenditure of money.

The whole problem of waterpower engineering is full of uncertainties, due to such things as variation of the head, variations in the flow of water, the fact that a good deal of water is usually wasted throughout the year, and other factors which have an important bearing upon this subject.

In order to acquire the necessary knowledge and skill in these matters, apprenticeship in this branch of engineering is essential, and to those men who desire to go into waterpower engineering my advice is to try to get into the electrical department of some operating company so that they can learn at first hand the day-by-day practical considerations which influence waterpower plants.

The development of waterpowers is going to extend. It has become today one of the great branches of engineering work, probably the greatest in many respects. All kinds of engineers and engineering knowledge are required in the development of waterpowers, and the result, when the waterpower is well designed and built, is one which gives to all connected with the work an enduring satisfaction.

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and in service of that character any human being is going to find the best satisfaction and the greatest happiness. In other words, if you can all make contributions that are going to reduce the human effort in the production of articles so as to make them of less cost, which immediately means that they are going to be available to an ever-increasing circle of people, you are going to distribute to an ever larger number of people that happinesss and comfort and well-being to the community which spells progress to civilization, which means the onward march of the United States of America or any community of which we happen to be a part, that is the finest contribution that the engineer can make to the problems of society.

[Abridged from stenographer's notes of lecture.]

Submarine Plane Trials Under Way. The submarine S1 is now at the Naval Air Station at Hampton Roads, Va., and trials with the submarine planes are in progress. The trials commenced on October 16, and will be continued for some time, to demonstrate the practicability of aircraft operations from a submarine. The planes to be tested for this work are the XS1 and MS1 type. These planes were designed especially to be carried on board submarines and are the smallest service seaplanes in the world.

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to tell of the experience they had in developing various enterprises, they would all tell you that nothing that they have had to do with has gone through to the full measure of success without having been at one time *almost* a failure. I know it has been so with everything I have had to do with. You can stop at the wrong time, and if you do, the undertaking is a failure and you are a failure. But if you stick to it, anything that has fundamental merit can in time be made a success.

So the only word of advice I have to give to you men is that when you go out from Tech you not only remember that it is your duty to uphold the traditions of the foremost technical institution of this country, but it is up to you to try and do something that is reasonable, something that is constructive, and if you take my advice you will not lose any time in joining the Stick-to-It Club and proving that in the bright lexicon of youth there is no such word as fail.

INCREASING THE EFFICIENCY OF GASOLINE

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telluride is an anti-knock material, but benzene is not. Although benzene, if present in sufficient concentration, removes the tendency of kerosene to detonate at compressions which are used commercially, it apparently does so simply by virtue of the fact that it itself is a fuel that will withstand a very high compression without detonating.

A compilation of the relative effects of a number of anti-knock materials is given in Table II. Benzene is used as a basis of comparison, and relative values are given for the various materials on the volume and the molecular bases. From the table it may be seen that, when compared with benzene in 25 per cent concentration in kerosene, one volume of diethyl telluride is equivalent in effect to 250 volumes of benzene, and one volume of lead tetraethyl is equivalent to about 625 volumes of benzene. If comparison be made on the molecular basis, the figures show that one molecule of diethyl telluride is equal in effect to 330 molecules of benzene, and that one molecule of lead tetraethyl is equivalent in effect to over 1,400 molecules of benzene. A better impression of how small an amount of some of these materials need be present in a combustible mixture in order to exert a marked influence on the character of the combustion may be gathered from the values given in the last column of Table II. Thus, for a theoretical mixture of kerosene and air, assuming that the average molecule of the kerosene is $C_{13}H_{28}$, one molecule of lead tetraethyl in 215,000 molecules of total mixture exerts an influence on the tendency of the fuel to detonate which is equivalent to about 25 per cent of benzene in the kerosene. In view of the exceedingly small amount of this material that is present in the reaction mixture, it exerts an influence on the character of internal combustion, which is so powerful that it at least bears a close analogy to a catalyst.

As happens almost invariably, this theoretical study of the mechanism of detonation in an internal-combustion engine has led to developments of highly practical importance. The General Motors Corporation is putting now on the market a high efficiency fuel, which eliminates the knock, thus producing full power and making any car easy and smooth to drive under all conditions and roads. This new product, called "Ethyl Gas," is ordinary gasoline, to which the desired amount of anti-knock material has been added. The new product is sold at present in Ohio, where the discovery was made, and it will be available for use in all the States of the Union as soon as the production can be made to meet the demands.

As soon as the anti-knock materials were known, the General Motors Research Corporation called upon the Research Laboratory of Applied Chemistry of Massachusetts Institute of Technology to help make the use of anti-knock compounds possible outside of the laboratory.

There is indeed a long way from making a laboratory test, regardless of cost, on a rare, unstable compound, hard to prepare by delicate methods, to manufacturing the same compound by the ton and making it altogether an economical success.

First under Prof. R. E. Wilson, and now under Prof. R. T. Haslam, compounds were prepared and tested that had never been prepared before, and methods were developed by which compounds are now being manufactured by the ton which, outside of this country, are still considered as laboratory curiosities.

It seems certain that it will be only a matter of time until all gasoline will be treated with an anti-knock material, and automobile engines having higher compressions and giving considerably greater mileage per gallon will be used. The principal effect of the use of anti-knock compounds will be the much further removal of the time when the threatened exhaustion of our petroleum reserves will actually occur.

TABLE I

Element	*Typical Compound*	*Effect on Reaction Velocity of Combustion*
Iodine	Element	Retards
Bromine	Element	Accelerates
Oxygen	Element	Accelerates
Oxygen	$C_2H_5NO_2$ or $C_2H_5NO_2$	Accelerates
Nitrogen	$C_6H_5HN_2$	Retards
Selenium	$(C_2H_5)_2$ Se	Retards
Tellurium	$(C_2H_5)_2$ Te	Retards
Tin	$(C_2H_5)_4$ Sn	Retards
Lead	(C_2H_5) Pb	Retards

TABLE II

Element	*Compound*	*Percent by Volume in Kerosene required to Effect a Given Suppression of Detonation*	*Number of Gram Molecules in Resulting 355 cubic centimeter Mixture with Kerosene to Give Equal Suppression of Detonation*	*Approximate Number of Molecules of Theoretical Fuel-Air Mixtures in which one Molecule Exerts an Effect on Detonation of a Given Magnitude*[1]
	Benzene	25.0	1.0[2]	150
Iodine	C_2H_5I	1.6	0.07	2,150
Nitrogen	Xylidine	2.0	0.059	2,600
Tin	$(C_2H_5)_4$ Sn	1.2	0.021	7,100
Selenium	$(C_2H_5)_2$ Se	0.4	0.013	11,750
Tellurium	$(C_2H_5)_2$ Te	0.1	0.003	50,000
Lead	$(C_2H_5)_4$ Pb	0.04	0.0007	215,000

[1]The computations of these values have been made on the basis of a kerosene having $C_{13}H_{28}$ as its average molecule.

[2]Twenty-five per cent by volume.

MONTHLY NEWS

Balloon Tires Perfected. Mr. Colin Macbeth, experimental and development engineer of the Dunlop Rubber Co., Birmingham, England, has arrived in this country on a visit to American tire manufacturers whom he hopes to interest in the standardization of the balloon tire which he has been developing in England since 1916.

In the years that he has been interested in balloon tires he has made several tests with them on his own vehicles. He has found that they give a maximum of comfort and an assurance of safety unobtainable with the ordinary pneumatic. On a twelve horse-power touring car equipped with "balloons" he drove up Snowden, the highest peak in Wales, in two hours. This drive of four thousand feet was made between the rails of an inclined railroad which necessitated running over thousands of metal ties. When a quarter of a mile from the peak one tire was punctured, but the drive was continued as it was not until the top of the mountain was reached that the puncture was observed. The possibility that balloon tires will reduce the speed of automobiles is discredited by Mr. Macbeth, who states that on the Brookland speedway "balloons" maintained the speed set by machines with ordinary tires. With low pressure tires it is possible to make a speed of one hundred and fifty miles per hour because the newer type remain very cool.

The parking problem may be greatly simplified by the use of balloon tires. Balloon tires insure a maximum of comfort in the small car, which with the smaller operating costs should increase their popularity. With the elimination of the larger cars more space will be left for the smaller cars.

One of the greatest points about the low pressure tire is its great factor of safety. Tests have proved that even at a rapid rate of speed a puncture or blowout with "balloons" is perfectly safe, where with ordinary pneumatics the car would swerve and in all probability strike some object. Then, too, a balloon tire may be run miles when flat without damage to either case or tube.

The "low pressure" pneumatic is of much larger section but lighter construction than normal tires, the former quality enabling it to carry the required load and the latter permitting the walls to flex easily. The method of attachment is of particular interest and importance. Tires used at very low pressures must not be dependent upon the air pressure for retention of the rims — an objection which applies to the present type of beaded edge tire. The Dunlop "low pressure" tire is of the wire edge type used in conjunction with the Dunlop-Welch cycle rim — a special light "onepiece" rim having a "well" or sunken base, enabling the tire to be fitted or removed without the use of any tool. When fitted it is absolutely secure and cannot become unintentionally detached even when deflated, the wired edges being retained in position by a special molded safety rib which rests over the rim edge. Extended tests have demonstrated the complete reliability of this attachment and have shown that neither punctures nor sudden deflation are a source of any danger. The deflation of these tires even from a big cut is sufficiently slow to enable the driver to retain full control of the car.

While the primary object of the tire is to give more comfortable riding and reduce vibration, certain other advantages necessarily follow. Higher speeds can be maintained over bad road surfaces, "rattle" is reduced, lighter axles, chassis and body-work are permissible, and the cost of car repairs is reduced to a minimum. Also because of the greater area of the tire in contact with the road there is less liability to skid. — *Rubber Age.*

Lumber from Sugar Cane Pulp. In October, 1921, the Louisiana Celotex Company began the manufacture of an extraordinarily serviceable building material from bagasse, or crushed cane stalks, a refuse of the sugar mills of Lousiana.

In principle, the bagasse is fed into a cooker, where it is combined with chemicals, and a small amount of old newspapers, and as a pulp it is fed into rolls twelve feet wide, then carried on rollers over a runway nine hundred feet long and heated to three hundred degrees. At the end it comes out an absolutely dry board, sawed in lengths of eight feet, four feet wide, ready for shipment.

In Australia there is little or no merchantable timber grown, and it is figured that Celotex will become the universal building material for that island continent. Even in the States Celotex is finding an astonishingly wide range of uses. As an insulator it is said to rank about on a par with pure cork, and to have much greater strength. For sheathing, a strength test is recorded as having shown that it had been displaced less than half an inch under a load pressure of twenty-six hundred pounds, whereas ordinary board sheathing had become 5.54 inches out of plumb at a load pressure of sixteen hundred pounds. Strength and insulation, it is declared, are thus combined as in no other building material in use. As insulating lumber it keeps out the cold in winter and the heat in summer. Although strong and durable, it is light in weight, weighing approximately six hundred pounds per thousand square feet. As a result of tests it is declared to be practically impervious to water, and the claim is made that it can be made fireproof.

Reconstruction of French Mining Industry. Remarkable progress has been achieved in the reconstruction of the French mining industry, systematically destroyed in war-time by the invading Germans, according to George S. Rice, chief mining engineer of the Bureau of Mines, Department of the Interior. As a result of the splendid engineering skill employed in the restoration work, some of the finest coal-mining plants in the world have been constructed in the north of France, states Mr. Rice. Thousands of miners' houses have been built, replacing those destroyed. Much attention has been paid to welfare projects, with the result that the miners of northern France are undoubtedly better housed than miners in any other part of the world. Underground, the mines have been recovered to such an extent that they are producing about seventy per cent of the normal coal output. When all of the water has been pumped out of the mines, the coal production of northern France will be greatly increased over that of the pre-war period. Ingenious cementation methods have been employed in the restoration of mine shafts in which the iron linings had been blasted, admitting water, which flooded the mine.

Another "War Baby" Finds a Home. Passing a camel through a needle's eye would be some job. Even the threading of a fine needle with one of the finer grades of thread requires a considerable amount of skill and patience. But when it comes to handling the almost microscopic wires used in the manufacture of the thermocouple and other delicate measuring instruments in the Bell System Laboratories of the Western Electric Company, you have something which requires infinite skill and patience.

These tiny wires which can just be seen by the naked eye make a hair take on quite huge proportions. The smallest of the wires used in this work is a platinum one only two hundred millionths of an inch in diameter. It would take a good one hundred of these to make a wire the size of the hair in your head.

In the manufacture of the thermocouple three practically invisible wires must be welded together at one point as well as being welded to the heavier lead wires at four other points. Although this is done under the microscope by especially developed tools, it still remains a job requiring a generous amount of patience.

The thermocouple which is used in measuring the small alternating currents in telephony and radio, and in adjusting circuits in the vacuum tube repeaters on long distance telephone lines is one of the many American "War Babies." Prior to the war they came from Germany. When that crisis cut off the supply from abroad the Western Electric Company began experimental work on thermocouples, and now better thermocouples are being made here than came from the foreign source.

A small fuse is used in the circuit to protect the thermocouple from stronger currents than it is designed for. Wires made up from a copper-nickel alloy are used in these fuses. The wires are four hundred millionths of an inch in diameter. As it is impracticable to draw such fine wires through dies to bring them down to the proper size they are put through an electrolytic acid bath where they are eaten down to the desired size.

Liquid Oxygen Explosive has been successfully used in Colorado by the Department of the Interior in experimental mine blasting and road construction work at a cost of approximately one-half that of the gelatin dynamite required to do the same work.

A liquid oxygen explosive consists of gas black, wood pulp or some other carbonaceous material made up into cartridges and soaked in liquid oxygen. This explosive can be detonated similar to ordinary dynamite with cap and fuse or with electric detonators.

As the use of this explosive is new in this country, numerous tests and experiments were necessary to find a low-priced carbonaceous material which would have the desired qualities and to learn the technique of blasting with this new material.

Hand steel holes were blasted in granite on a road construction job above Idaho Springs, with results similar to those obtained with forty per cent gelatin dynamite. Trees were also cleared from the right-of-way and a two hundred-ton cliff blasted down successfully. Instantaneous electric detonators and blasting battery were used for this work and no misfires occurred and no holes failed to break properly. The oxygen was taken to the job in an automobile and the quantity not used was taken back to Denver.

Regular drift rounds were blasted on the two hundred level of the Yak mine. The oxygen was expressed from Denver and a cartridge developed and made at Denver was used. Eleven and thirteen-hole rounds, four to five feet deep in a seven by eight-foot drift, in firm limestone, were successfully shot with the liquid oxygen explosive. The rounds were loaded and blasted by two men in eight to twelve minutes, which was well within the life limit of the cartridges. The blasts were made according to the standard practice in western mines with time fuse and caps. The rounds were broken clean in each case and the broken material was finer than when blasted with forty per cent gelatin dynamite. Disregarding the express charges on the oxygen, the cost of this liquid oxygen explosive was about one-half that of the gelatin dynamite needed to break the same round. Besides costing less, the liquid oxygen explosive is much safer to use than ordinary dynamite. There are disadvantages resulting from its use, however, and much is yet to be learned before it can be universally adopted in metal mines.

Twenty-Inch Blast Furnace. The study of the reduction of iron ore in the blast furnace, which has been in progress for four years by the Bureau of Mines, Department of the Interior, at Minneapolis, and which has resulted in the successful development of an experimental blast furnace by the bureau's metallurgists, has yielded data that may lead to important modifications in the present design of blast furnaces. The Bureau of Mines engineers are able to make iron successfully in a small furnace which has a stack twenty feet high and a hearth twenty inches in diameter, and the tests show that a considerable part of the stack is inactive, so far as reducing effect of the furnace gases on the ore is concerned, between the combustion zone and the zone near the top where reduction is actively going on. Since nothing happens in this part of the stack, if the same conditions hold true in commercial blast furnaces, the present tall stack universally employed could be shortened, thus reducing cost of construction, and size and cost of equipment such as the blowing engines that drive the furnace.

Limiting Coal Dust Explosions. In Great Britain and France the employment of rock dust as a screen or barrier for the limitation of coaldust explosions to the immediate area of the explosion has been made compulsory. The efficacy of this method was strikingly demonstrated in the case of a gas explosion in a Yorkshire colliery where the stone dusting confined the explosion to its immediate place of origin and prevented the great loss of life that must have occurred had the explosion spread through the mine.

BOOK REVIEW

Blueprint Reading. By Joseph Brahdy. D. Van Nostrand Company, New York. 134 illustrations, 11 by 8¼. 108 pp., cloth, $2.50. 1923.

It has been frequently noted that the average graduate of a technical school, as well as many engineers, are unable to read a blueprint correctly or to construct one from an object. The student in drawing is also often confused about the construction of a drawing from an object or blueprint.

In "Blueprint Reading" the student will find a valuable book for reference and instruction. It is a text that aeaches the reading as well as the construction of blueprint drawings, and as such is of value to the engineer and student alike. Beginning with a general outline of the subject, its purposes and scope, the author develops his subject from the simple isometric to the finished assembly drawing. Visibilities, dimensioning, scales, orthographic projections, conventions, and the like are taken up in logical order. The material is presented simply and clearly, a sketch being used to illustrate the principle wherever possible. Following each new series of conceptions is a set of questions serving to emphasize the major points taken up in the chapter. Numerous photographs of objects with working drawings are included to illustrate the method of showing various features.

The engineer desiring to better acquaint himself with the reading of blueprints and the student wishing a clear reference book will both be highly pleased with "Blueprint Reading".

EDITORIALS

SUCCESS IN LIFE

Success in life! The young expect it, the old sometimes achieve it, everyone wants it. The eager youngster, impatient to be at the game, is certain with the confidence of youth that he, at least, can show his elders how it should be played. They are not so sure; they were crusaders once themselves and the pages of the past tell only too well the tale of abandonment of the high hopes of their youth. To some, Time has indeed brought fulfillment of dreams so glorious they had not dared to dream them. Yet even they, the successful, find success a fugitive sort of thing — a wily fox. And if, in the grandest hunt of our lives, we are to make the great kill, we must know our prey. Let us consider our fox.

Stevenson tells us this: "To be honest, to be kind — to earn a little and to spend a little less, to make upon the whole a family happier for his presence, to renounce when that shall be necessary and not to be embittered, to keep a few friends, but these without capitulation — above all, on the same grim condition, to keep friends with himself — here is a task for all that a man has of fortitude and delicacy."

And Thackeray, writing on the deaths of Macaulay and Irving, says: "Here are two examples of men most differently gifted — each pursuing his calling; each speaking his truth as God bade him; each honest in his life; just and irreproachable in his dealings; dear to his friends; honored by his country; beloved at his fireside."

Certainly here is no talk of great achievements, of huge fame, of vast fortune. Success is not of such stuff as these. All men have in this life a duty to their God, to their fellow men, and to themselves. And it is in the manner in which they discharge these duties that we must look for the measure of their success.

To any observant person the dictum that "All men are created equal" must appear a fatuous fallacy. Men come into this life with endowments of infinite variety; and live it under an infinite variety of circumstances and conditions. Some come with great gifts, some with few. Fate treats some kindly, some cruelly. One hardly dares to say who has success. This far, however, I think we are safe: If any man, howsoever gifted, howsoever treated by Fortune, refuse to use his gifts to do what comes to him as best he may, refuse to accept his opportunities to do his duty toward himself, toward his fellow men, and toward his God; if any man say to himself, "Having come so far, I am a success," and so saying, lay down his arms, refuse to carry on, to fight on to the very finish, — that man we must count a failure. And I think we must count the greatest failure of all him, who, gifted above his fellows, does not fight on so much longer, so much more nobly, and so much harder. . . . There is a parable in the Gospel of St. Matthew about three servants and some talents.

Success in life is indeed a fugitive sort of thing. It is, to change the figure, a will-o'-the-wisp, seen always just beyond the barrier of the greater thing you hope to do. You clamber somehow over the barrier of today's greater thing and lo! there is success seen just as certainly beyond tomorrow's. You catch it, if at all, at death; for then there is no, at least no earthly, tomorrow.

But for many of us, indeed — alas, for most of us, today's barrier will be tomorrow's as well. And those of us who do clamber over see that somehow we have not done it so neatly as we might, so neatly as we had hoped. And so Barrie, speaking to the students of St. Andrews, says: "When you reach the evening of your days you will, I think, see — with, I hope, becoming cheerfulness — that we are all failures, at least all the best of us."

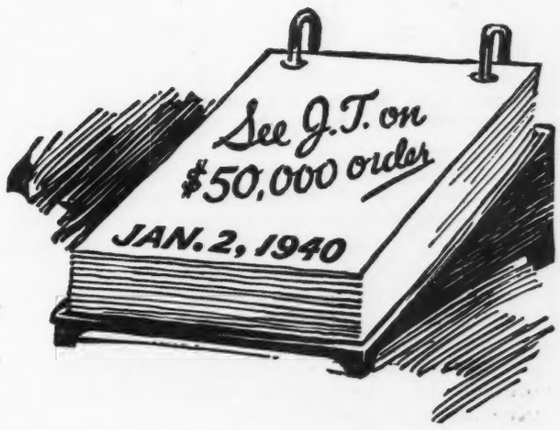
It is not given to all of us to do the great deed, to say the fine word. Yet if we go our ways cheerfully, humbly, and courageously, doing the right as we see it, avoiding what Stevenson calls the greatest mistake of our lives, "that we are all trying to gain the whole world if you will, except what is alone worth keeping; our own soul," perhaps, though we miss the earthly prize, we shall not have failed, after all.

DANGEROUS POLITICS

There has been a great deal written about the engineer taking part in governmental and political affairs. Undoubtedly this would benefit the country very much and should be encouraged. But if we expect competent engineers to forsake industry for civic service we must guarantee them fair play and eliminate such practices as are pointed out in a current editorial of the University of Virginia *Journal of Engineering* which is given here in full as follows:

"A few weeks previous to the appearance of this issue of the JOURNAL a heavy political 'stick' was used in Washington in such a way as to clearly define the handicap under which one of the most important departments of the Government is at present laboring. Secretary of the Interior Hubert Work, feeling the embarrassment of a political debt as yet unpaid, ousted one of the most efficient and talented engineers that the Reclamation Service has ever had in its employ. Arthur Powell Davis, one of the leading engineers of the country, without preliminary notice of any description, was notified that his services were no longer needed; this, with the abrupt tone of the notice, was particularly insulting to a man of such accomplishments. This engineer, ousted without reason and with scant courtesy, has been replaced by a politician, a political friend of Secretary Work. It is interesting to note that the second head of the Service, also a Mr. Davis, has done absolutely nothing to warrant such confidence that seems to be placed in him. Secretary Work made the lame excuse that a business man was needed for the position, inferring that Mr. A. P. Davis was not a business man and that his successor is. The first inference so derived has been shown to be without grounds, for the very government of which Mr. Work is 'agent,' has requested that Mr. Davis, if matters are capable of being so arranged, go abroad and act as its representative in a deal in which high finances are involved. The successor has never been a business man, has never exhibited any inclination in such a calling and has never given indications that he would.

This condition of affairs clearly shows that the scientific and engineering branches of the Government must be beyond the reach of politicians adhering to the 'spoils system' and for efficiency entirely beyond the grasp of politics."



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Number 34 of a series

HUMANICS AT NELA PARK

(*Continued from page 204*)

closely analagous to the brain of a body, only in this case the body is a group of factories and sales organizations that stretch from New York to California. Only such work is carried on at Nela Park which experience has shown to be more economical to undertake in a centralized manner for all the factories and sales organizations, than it would be for each of these units to accomplish these things for itself. Each of these activities at Nela Park is a separate department with its own manager.

The problem of creating the proper spirit in these managers has been solved in an absurdly simple manner. The officials recognized that the desired virtues of self-reliance, initiative and enthusiasm, were best brought to the surface when a man worked for himself.

Why not, as far as consistently possible to all intents and purposes, have a man work for himself? Accordingly each department head conducts his work as though he were in business for himself. He alone manages, asks for the desired appropriations, makes expenditures and with his associates, produces results. He is only responsible to the administrative officials for results, and these results in profits or benefit to the company, are the only reasons he can put forth for the continued existence and growth of his department. The possession instinct is also appealed to in a more practical way, through allowing departmental and sales managers to become monetarily interested in the successful operation of their particular fields of endeavor.

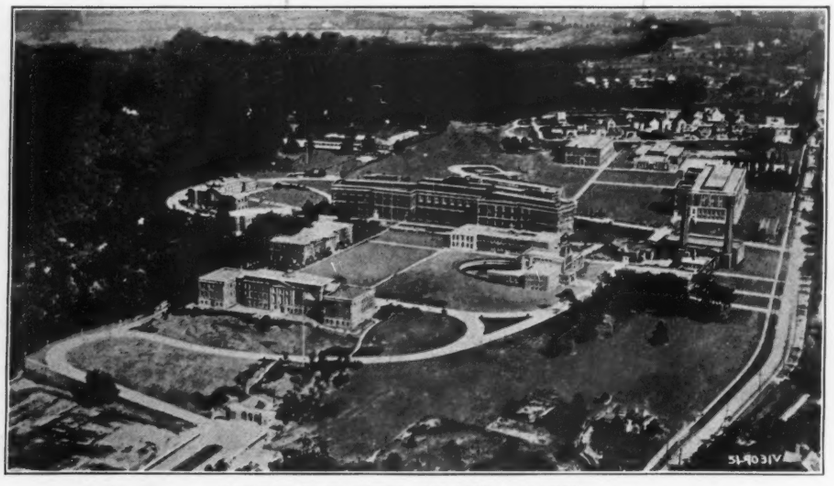
This idea of individual responsibility is carried out wherever and whenever possible. From the manager down to the departmental stenographer there is a strong vital feeling, that in some way the work of the entire company depends upon the successful execution of the individual's task. It is well known that, as the lower levels of the workers are reached, this decentralization of responsibility must be carried out at a constantly decreasing rate, and that the net effect is less. However it is also true that here is where the more obvious factors used in the solution of this problem in humanics play a more important part.

Now we call attention to work classified by sociologists and economists as employee welfare work. The National Lamp Works at Nela Park, seems to have gone farther into this field than other similar institutions. There is in effective operation a well constructed plan of employee insurance and old age pensions. Interest in the company and savings are encouraged by the sale of stock to the employees at very advantageous terms. Should he care to do so, an employee may place some savings in a fund which is handled by company officials of competent banking and investment experience, for investment purposes only. Invariably this method has resulted in a larger return on savings to employees, than the employees could have hoped to earn by their own investments. Free medical and dental aid is available at all times. The legal talent of the company is at the service of the employees to aid them in the solution of their personal problems. Last and probably most immediately effective are the liberal provisions made for athletic recreational exercise in the form of tennis courts, swimming pools and baseball fields. On account of prohibitive costs, some of these advantages would be denied the employees did not the company provide them. It would be difficult indeed, to limit to a definite figure the actual dollars and cents value of the undertakings to the National Lamp Works.

The only reason for the continuance of these methods is a satisfactory answer to the question; are these methods a success? For an answer we can do no better than look to the present position of the lamp industry, at the apex of which stands the National Lamp Works. In a little more than a dozen years the industry has risen from a condition of cut-throat competition, poor product, lack of working standards, and a multiplicity of other sins, to a plane of high business ethics, managed and directed upon sound economic principles, and led towards the future by the scientific research of the best brains available. While keeping alive that essential stimulus of competition, it has shown the rest of the business world the road towards constructive coöperation. The lamp industry has in no small way contributed to our nation's predominant position in world industry. With adequate lighting, our production efficiency has been increased through lengthening the working to twenty-four hours if necessary, to say nothing of the recent increases in rates of production through the achievement of high intensity glareless illumination. Electric lighting in our homes competes very favorably with daylight, both as to charm and efficiency. The actual efficiency of the unit electric lamp has been increased some five hundred per cent. In short, this is a record of the past that the industry can well be proud of, and it bids fair to do even more than this in the future.

In the van of the movement of this progress has been the National Lamp Works. Since Nela Park has been established, not only have labor troubles been unknown, but what is more important, most of the valuable and easily adoptable suggestions for improvements and new methods have come from the employees. When so pushed by the hearty coöperation and enthusiastic loyalty of its workers, it is hard to see how the National Lamp Works can lose its leading position.

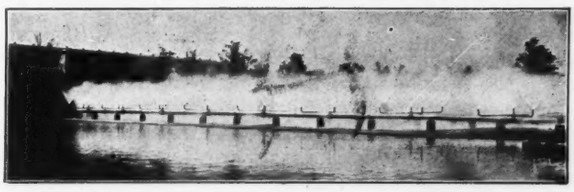
To remove any lingering doubts as to the value of work in problems of humanics, we may well try to answer the question; can these methods be adopted in other organizations. We fail to find a single argument for not doing so. After making all the necessary charges for lawns, flower gardens, tennis courts and shady drives, the annual cost to each department of a square foot of office space at



BIRD'S EYE VIEW OF NELA PARK

(*Continued on page 228*)

Spraco Cooling System



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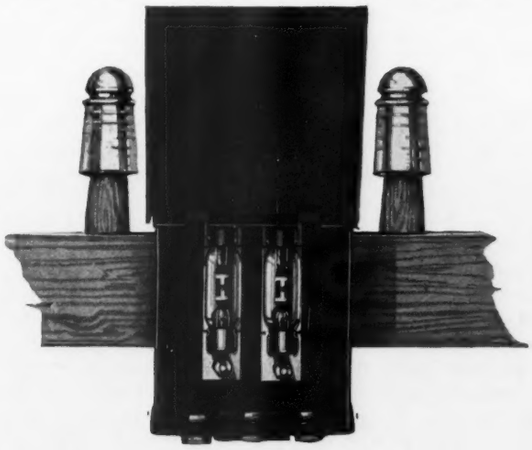

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HUMANICS AT NELA PARK

(*Continued from page 226*)

Nela Park is approximately one-third of what similar space would cost in a downtown skyscraper. Here may be seen the origin of the term horizontal skyscraper, as applied to Nela Park, in contradistinction to the ordinary vertical skyscraper. Quiet and freedom from disturbing noise vibrations were essential to the research laboratories, but no less beneficial to the health and happiness of the other workers. In this age of almost instantaneous communication and rapid transportation, there is no good reason for non-retail establishments further augmenting the terrific crush and crowded conditions of cities with administrative organizations that, experience has shown, may function ably under more sustaining conditions. It is hard to believe that this work in the problems of humanics, whose satisfactory solution redounds to such benefit of all concerned, will not continue, and in a measure remove the repressive and unhealthful elements which brain work ordinarily carries with it.

IMPORTED AUTOMOBILE SHOW

(*Continued from page 205*)

illustration shows the general appearance of the chassis. An interesting feature of this engine is the use of a V-belt drive for the generator in which the belt is enclosed in the crankcase. In view of the difficulties experienced with belt drive for generators the enclosure of the belt seems to be of questionable value.

Panhard and Minerva also show Knight engined chassis which are practically the same as their previous models. Panhard continues the use of the two four-cylinder magnetos for an eight-in-line engine in spite of the apparent difficulties of synchronization.

Isotta-Fraschini exhibited the large eight-in-line which has been so successful. The beautifully clean lines, characteristic of Italian chassis, are a notable feature of this model.

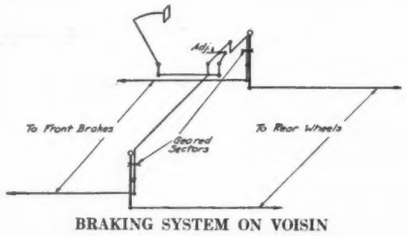
Fiat exhibited the 10–15 h.p. "Baby" model and also a six-cylinder 75 mm. x 130 mm. (12.95″ x 5.51″) model. The type 519 six-cylinder overhead valve model which was expected to be shown did not appear. This model was shown for the first time at the Paris Salon last year and is particularly interesting because of the complete enclosure of the accessories. This feature was introduced in 1915 on the Fergus car and was first put into production on the post-war 17–60 Austro-Daimler.

Three models of the Renault were on exhibition, a four-cylinder 85 mm. x 140 mm. (3.34″ x 5.51″), a six-cylinder 110 mm. x 160 mm. (4.33″ x 6.29″) and a very small four-cylinder 6-h.p. model. The two larger models were equipped with four-wheel brakes.

In view of the great interest in four-wheel brakes it may be of interest to note the features of the systems used on these various cars. The Perrot system was used on Voisin, Minerva and Renault. Isotta-Fraschini, Mercedes and Panhard use their own designs.

The extremely neat and complete enclosure of the universal and telescoping joints on the Voisin and Minerva are very interesting, especially when compared with the complete exposure of these parts on the American adaptations of this system. Renault also uses the open type of joint.

The operating mechanism on the Voisin is very interesting and is shown diagrammatically in the sketch. The braking effort is equalized between the two sides by means of an ordinary equalizer bar. From the cross tube the



BRAKING SYSTEM ON VOISIN

effort is divided between the front and rear wheels by means of the compound levers. The main arm of the levers is pivoted about the axis tube, the motion is transferred first to the small lever and through it to the main arm. While this mechanism equalizes the effort on each side it also seems to apply the rear brakes first and then brings the front brakes into action very rapidly.

The hand lever operates a set of brake shoes on a second pair of drums on the rear wheels, these drums being located within the service brake drums. The lever is mounted in the center of the car mounted on a tube concentric with the cross tube of the service brake. On each end of this tube and just inside the service brake arms is an arm projecting downwards, carrying a bell-crank at its lower end as shown in the sketch. The purpose of this mechanism is to reduce the leverage which would obtain if the cables were connected directly to the ends of the arms, since the arms must be long in order to clear the cross members of the frame. The entire mechanism while apparently complicated, is worked out in an extremely neat manner. The drums are well ribbed for rigidity and cooling.

The Isotta-Fraschini braking system is so well known that it needs no further discussion here.

The Mercedes front brakes are operated by cables which pass over pulleys mounted on the upper end of the king pins, whence they are led directly into the frame where they pass around a pulley and are led to a cross tube under the floor boards. A differential equalizer is mounted on this tube. A contracting brake is mounted just aft of the transmission and also two expanding brakes on the rear wheel hubs. The interesting feature is in the way in which the various brakes are linked together. The pedal is arranged so that it operates the shaft and front brakes while the lever operates the rear wheel brakes and the front brakes. The front drums only are provided with cooling fins. This design has a number of good features, but the variation in cable position due to the flexure of the springs would appear to make the operation of the front brakes rather irregular.

The most interesting feature of the Panhard brakes is the use of large diameter tubes for their operation. This construction ought to eliminate the vibration so common to thin rods, cables, and metal straps.

The Renaults are fitted with a friction servo mechanism and the Minerva uses the Perrot semi-servo. In the latter the two brake shoes are hinged together, the cam acting on the first shoe, the rear of the second being fixed. In this way wrapping action is provided, together with practically complete elimination of the danger of locking the front wheels. The ability to secure wrapping with internal brakes appears to remove the chief claim of the American exponents of external brakes.

It is a significant fact that no European car of any importance whatever uses external brakes, except in the case of shaft installations. Due to the rather light loading of these brakes, and what is more important

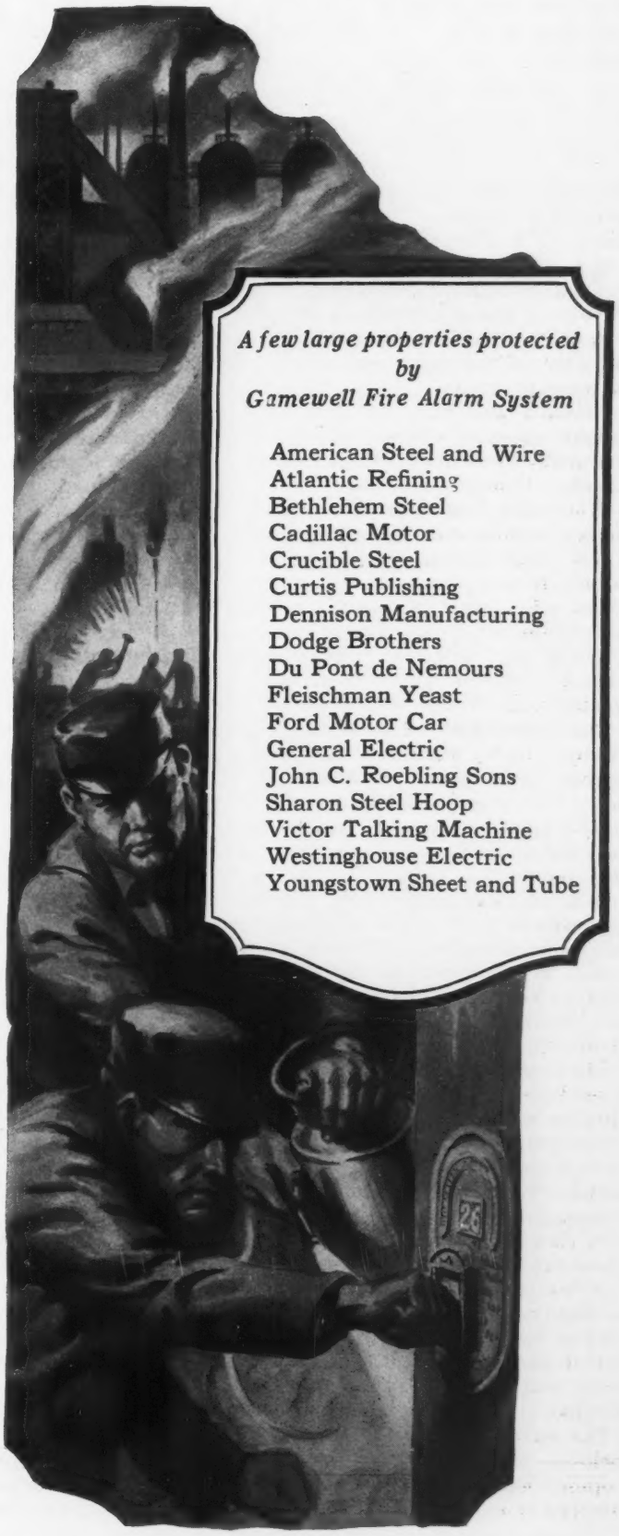
(*Continued on page 230*)

FIGHTING FIRE
- in the Steel Mills

TWO hundred and six alarms of fire were received over the fire alarm system of one of the large steel companies of the country during the month of September. Of these only one resulted in any serious loss, and that amounted only to $700. Over five hundred trained men are available for fire fighting in this particular company and the fire brigade is equipped with all modern fire extinguishing devices.

These plants represent a life and property hazard much greater than in cities of equal size. They require prompt skilled action by the fire brigade, and the records indicate that the fire brigade furnishes it. Their fire alarm system must rank up with systems in similar-sized towns and naturally they came to Gamewell when the fire alarm question was considered a number of years ago.

Thousands of these industrial plants have installed Gamewell Systems which ranged all the way from a single box to a most complete system.



A few large properties protected by Gamewell Fire Alarm System

American Steel and Wire
Atlantic Refining
Bethlehem Steel
Cadillac Motor
Crucible Steel
Curtis Publishing
Dennison Manufacturing
Dodge Brothers
Du Pont de Nemours
Fleischman Yeast
Ford Motor Car
General Electric
John C. Roebling Sons
Sharon Steel Hoop
Victor Talking Machine
Westinghouse Electric
Youngstown Sheet and Tube

THE GAMEWELL COMPANY

NEWTON UPPER FALLS, MASS.

FIRE AND POLICE SIGNALLING SYSTEMS

IMPORTED AUTOMOBILE SHOW

(*Continued from page 228*)

their good protection from water and mud, contracting shoes appear to work satisfactorily. The newer cars using shaft brakes, however, are using the expanding type.

In conclusion, the outstanding feature of the show was the general cleanliness of design which is particularly noticeable when these chassis are compared with American cars in the same class. As beauty of outline without sacrifice to efficiency or accessibility is the final test of proper design, the American manufacturers have obviously much to learn.

ORGANIZATION OF A BUREAU OF HIGHWAYS

(*Continued from page 207*)

ceed uniformly, season by season, whereas construction may fluctuate periodically, depending upon the growth of the city and the relative urgency of the many demands upon the city's budget. Thus the routine work of a District is maintenance, which is carried out by a regular force of superintendents, foremen, and laborers. When surveying, resurfacing, or construction is contemplated, the District Engineer needs the help of one or more field parties with assistant engineers, transitmen, inspectors, etc., and such personnel is ordered to report to him by the Engineer of Construction.

Under the Engineer of Maintenance there should be a Superintendent of Trees. Notwithstanding the fact that people readily recognize the value of trees, only rarely is there a capable official charged with their propagation, transplanting and care. By the individual efforts of property holders a scattering arrangement of poorly selected trees may be possible; but, in order to have a really worthwhile tree system, full municipal control is necessary. The Bureau of Highways is the proper agency of the city government to take charge of tree planting and maintenance.

Plantings are usually not authorized for streets until both sidewalk and curb are in place. Tree work on the street then consists in digging holes, filling them with rich soil, planting, cultivating the earth around young specimens, protection of trees, trimming them, and insect extermination; all of which work naturally falls under the jurisdiction of the Engineer of Maintenance. However, if the tree system is at all large, he needs the assistance of a Superintendent of Trees, particularly so in view of the fact that the city should grow its own seedlings in a municipal nursery.

Directly responsible to the Engineer of Highways there must be an executive or business manager who may be called the Office Engineer. His office force consists of clerks, computers, and draftsmen, and his office relieves the Engineer of Highways of many tedious details. Requisitions, payrolls, the certification of bills payable, statements of allotment balances and other records affecting the finances of the Bureau are handled in this office. Here, too, all engineering records are likewise concentrated.

Having all data at once at hand, the Office Engineer is the proper person to deal with citizens applying for information as to prospective or desired improvements. Such business with the public requires much tact and ability, and a great deal of time is thus consumed. Not a building is constructed but information has to be obtained of the Bureau of Highways as to grades, sidewalks and terraces, and in many instances, as to curb and roadway improvements. Permits have to be obtained and deposits made in order to guarantee that public improvements such as sidewalks and trees will not be injured during the construction of buildings.

A most important duty of the Office Engineer is the control of work done in public space; as driveways across sidewalks and curbs, street openings by plumbers and utility cuts; together with the keeping of records and accounts connected therewith. This work is of such importance that a separate division is necessary under the Office Engineer, the duties of which may be discussed under a separate heading.

As the demands for modern conveniences of life multiply, it daily becomes more urgent to regulate properly the many constructions beneath the surfaces of city streets. Control is necessary for the regulation not only of the location of mains, conduits, and other sub-structures, but also of the cutting of pavements in order to install them. Provision must, of course, be made for water, sewer and gas pipes, and it is now not unusual to have to provide for telephone and lighting cables, for tunnels for industrial and commercial purposes, and in the larger cities of the land, for underground railways.

Before outlining in detail the work of the Division of Cuts, it is well to set forth briefly the larger aspects of the problem. Some sub-surface constructions, those of greater consequence, require special consideration by the City Government. Installations in accord with settled municipal policies are under the control of the Director of Public Works, who should appoint a permanent supervisory board consisting of the Bureau Engineers in charge of water, sewers, lighting and highways. Maps drawn to a single scale should be available from each bureau represented on this Board. On a set of maps from each Bureau are shown the substructure data pertaining to it. In addition it will be necessary for the Board to have prepared a set of maps showing all data not plotted by the several Bureaus.

A successful Supervisory Board is of lasting benefit to the municipality. First, by its allocation of sub-surface space, it conserves one of the greatest assets of the city, and incidentally, through making an accurate and complete historical record available, it facilitates the actual construction of improvements. Secondly, the Board regulates underground work by coördinating the grading work of the Bureau of Highways with desirable extensions of water mains and sewers and the like that should be made by the municipal bureaus or by private corporations. When new paving is contemplated, consideration is given to future as well as to present sub-surface requirements, and such work as is possible is done so as to obviate tearing up new pavement for a reasonable time. It may be advisable to order owners of vacant lots abutting the prospective pavement to install house connections into the building line prior to construction of the pavement. When the construction of longitudinal extensions or of new systems under existing pavements is desired, the Board gives consideration to the necessity therefor, and to the probable damage to existing surface improvements. Some cities have a fixed rule that new pavements shall not be cut for two or three years after being laid. It is believed to be better practice to depend upon the judgment of a Supervisory Board as has been outlined.

All cuts in pavements are made under authority granted by permits. If the permit is asked for a longitudinal cut, the matter must be referred to a Supervisory Board prior to issuance.

(*Continued on page 232*)

THE J. G. WHITE ENGINEERING CORPORATION

DESIGNS or **CONSTRUCTS** steam, water power, gas and chemical plants, steam and electric railroads, transmission systems, wharfs, bridges, hotels, apartments and houses, laboratories, office and factory buildings, oil refineries and pipe lines, and will perform such service as a part of clients own organization.

PURCHASES great quantities of apparatus, materials and supplies annually, which enables it to obtain advantageous prices for clients and speedy deliveries to all parts of the globe.

INVESTIGATES and **REPORTS** on the operating condition of properties, and also **APPRAISES** railroads, industrials and utilities.

43 Exchange Place, New York.

ORGANIZATION OF A BUREAU OF HIGHWAYS

(*Continued from page 230*)

If a permit is wanted for a service connection, or other small jobs, it issues automatically. In any case the Division of Cuts has prior knowledge of all impending work. This is primarily essential. It is likewise imperative that there be supervision of the restoration of surface conditions.

This restoration of surface conditions, or repair of cuts, should habitually be made by the District Engineers supervised by the Engineer of Maintenance. In exceptional cases it may be proper to permit such work to be done by a private corporation, but in such cases the work should be supervised by a City Inspector, and his salary charged to the corporation, which should also bear a proportionate share of the overhead expense of the Divisions of Cuts. Experience has shown it to be doubtful whether any economy ever results from permitting private enterprise to do such work. Public interests are best served by the city doing the work itself.

The Division of Cuts must be self-supporting, though a profit should not be made. In general, a special working fund is established by deposits made by public service corporations, plumbers and others finding it necessary to open up pavements. If a repair to a cut made by a municipal bureau is necessary, the fund is reimbursed by a transfer voucher. In some instances, instead of a deposit, corporations have been permitted to furnish a bond. Especially is this the case when the private concern is allowed to make the repair and the bond then serves as a guarantee of good work. Experience has shown the excellency of the deposit system. The amount maintained by a corporation may vary with conditions, and by a plumber fifty dollars appears to be a fair average sum. Bills should be rendered monthly, charges made against deposits, and, in each case, no permit for further work issued until, through payment of the bill, the deposit has been returned to its normal amount. With a satisfactory administrative procedure for the control of cuts it is an easy matter to arrange for their repair under the superintendence of the Engineer of Maintenance.

Information as to work in the field is furnished by means of a card system, which can be readily devised to meet local conditions. Upon the issuance of a permit granting authority to make a cut, cards in duplicate containing all necessary information are prepared. One copy is retained and the other given the District Engineer supervising work in the locality. Through his organization and knowledge of plumbers and others working in his district, it is an easy matter to prevent abuse of pavements in the making of cuts and to obtain good work when these private parties back fill their trenches. Surface repair is made by the District Engineer when conditions as to the type of pavement and back fill justify complete restoration.

Upon return of cards to the Division of Cuts with measurement and other data from the districts, proper charges against deposits are made. It is usual practice to base these charges either on actual cost plus a percentage for overhead or on flat rates. The former method serves well for unusually large jobs, but ordinarily a flat rate, that is, a listed charge per square yard for each type of pavement is fair, convenient and justifiable.

THE RAILWAY FREIGHT SITUATION

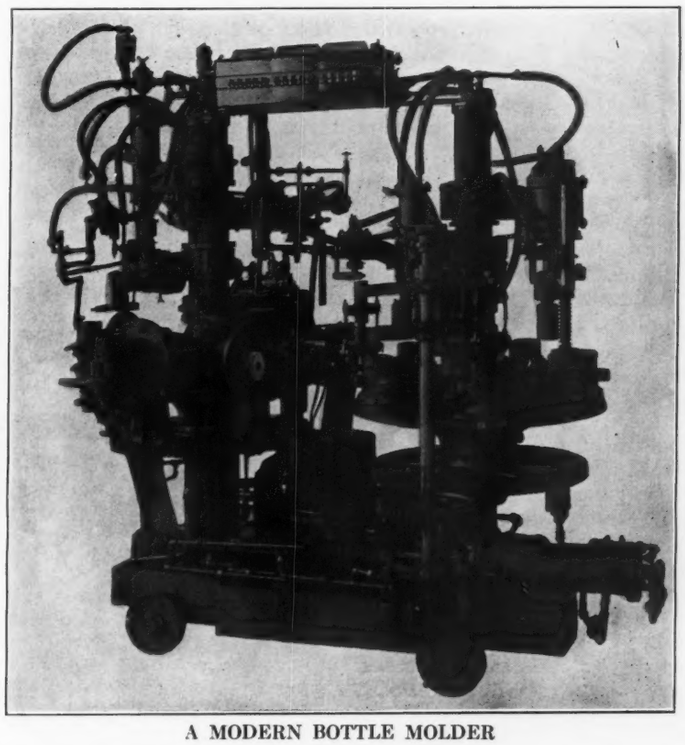
(*Continued from page 206*)

some twenty years ago. It is estimated that because of this one item alone the New Haven suffers a loss of six and a quarter millions a year.

Mention was made of the effect of the kind of commodities handled, on the terminal problem. The Baltimore & Ohio in operating its division terminal at Martinsburg, West Va., many years ago, changed engines, cabooses and crews in an eastward yard consisting of two, possibly three, long tracks adjacent to and parallel with the main tracks. Little delay and no difficulty was experienced with these facilities in making a reasonably quick "get-away." Some years later it was found necessary to make a considerable increase in the number of tracks, and other facilities, although there had been very little increase in freight traffic. While the tonnage had not increased appreciably, there was a decided change in the kind of freight. Where coal formerly formed the bulk of the business, along with some grain, an aggressive policy added considerable livestock, merchandise and miscellaneous freight. It became necessary to break away from the "first-in-first-out" system and to discriminate in the handling of separating certain kinds of freight into train-loads, giving some of it preferential movement over others. Again reverting to the New England situation, the high-class manufactured goods of that section, the short hauls, the persistent demands for fast time — usually the so-called "overnight" service — and the many cross-roads and junction points make it difficult to get a straight train-load for any given point, with any degree of frequency. This necessitates the use of more terminals, and of a highly intensive train and yard service. These conditions, in a like manner, have resulted in more awkwardly located and "hard to switch" industrial tracks than are found in other regions.

Along with all this, the operating officers are constantly entertained — and interested — by much orthodox propaganda regarding the beatitude of the big, bigger and "biggest" freight car, and its load; of the heavy and heavier train-load; the alleged operating efficiency as measured by these empirical formulas and by the story of the "nimble freight car" — the car-miles-per-day illusions. Many, if not all, these units are indicative of good (or bad) operations; but it is the height of absurdity to form conclusions on the basis of any one of them, taken single-handed. They must be considered as integral parts of the whole machine; and always, with due allowance to conditions affecting the operation, and should seldom, if ever, be used comparatively, except where a road measures its performance with its own previous record — or a division of a road with itself, even then, allowances and explanations must be made for conditions affecting one period and absent in the other. Were there no affiliation between the roads east and west of the Hudson River, that is to say, were the New England roads entirely separate from those of any other section — as are the roads of England, there can be little doubt that the light merchandise cars used in England, of from six to twelve tons capacity, would be more efficacious for the New England section. This would enable a far greater percentage of straight-loading, thereby avoiding that objectionable "necessary evil" — the transfer station — and the accomplishment of more "overnight" service, similar to the English practice. In this again, there is the necessity for conforming to trunk-line requirements which, while satisfactory for the country as a whole, are anything but conducive to the best interests of New England shippers, and their railroads. The extent to which trains

(*Continued on page 234*)



A MODERN BOTTLE MOLDER

From Raw Materials to Finished Product

FROM the raw materials to the finished bottle, each step accurately defined and executed, with care and precision marking every phase—thus has the glass bottle industry come to be one of our foremost manufacturing interests.

And, behind it all, is the bottle molding machine, that supreme engineering achievement that is virtually a mark in the progress of civilization. With rapidity and precision, this machine is capable of perfectly producing the world's most sanitary container in quantities and qualities, finishes and colors, that permits everyone to enjoy the benefits accruing from its use. Truly, the molding machine is the nucleus of the glass bottle industry, and on it has been lavished infinite experience and research in order that its product may be fully capable of satisfying the most exacting denands.

The SALEM GLASS WORKS, pioneer bottle manufacturers, have not only contributed much towards supplying the ever increasing demand for better bottles, but they have, as well, made numerous improvements on the bottle molding machine. Their staff of engineers and experts is ready at all times to give their prompt attention to your container problems and requirements.

SALEM GLASS WORKS

SALEM, NEW JERSEY

PRODUCERS OF THE BETTER BOTTLES

THE RAILWAY FREIGHT SITUATION

(*Continued from page 232*)

may advantageously be loaded heavily, depends on local conditions. A line largely given over to freight service, handling crude commodities permitting slower movement — and particularly where the maximum grades in the direction of predominating traffic are of short length, there is much to be said in favor of the heavy or heaviest train-load. On a line of heavy passenger traffic, handling perishable freight, livestock and high-class merchandise in considerable volume, a lighter train loading may be desirable. In each instance it is a problem for the particular road involved, which must, in addition to the cost standpoint, give thought to the limitations of the physical road and terminal facilities and the service necessary to care for perishable and high-class merchandise freight. Consideration must be given to the general design and track capacity of a terminal, which necessarily limits the length of trains that can be economically received or dispatched and conversely, the size of trains may tend to retardation of the movement of freight.

The increased use of the so-called "main-tracker" has possibilities where the facilities and character of business permit. This is the "overhead" movement of the greatest number of trains possible through terminals. It is, in other words, a newly coined word for the old-fashioned and well-known transportation axiom to make up straight trains to as many, and as far distant, points as practicable — and to keep them moving. It may be expressed in the equation of having cars held to make up straight trains to a destination so long as the terminal delay will equal or not greatly exceed — the delays eliminated in switching and re-switching at the several terminals along the route.

Each line is its own problem. An attempt was made, not long ago, to compare the operating efficiency of two transportation lines, working under wholly dissimilar conditions, by the use of the "car-miles-per-day" formula alone. A thorough analysis of this subject alone, with all its ramifications, would be too long for this article. It suffices perhaps to say there are many and devious ways of adding to the "nimbleness" of the freight car, without producing real operating economies. Freight may be loaded long distances, to and through transfer stations, adding to the mileage of both the car and its contents, but not adding to the miles of the contents for which remuneration is received. A case occurred where less carload (package) freight, shipped from one point to another — twelve miles distant — was actually carried some two hundred miles before it reached its destination, and this freight was not "astray." A western road, whose average ton-mile-haul ranges around two hundred and fifty miles, readily gets sixty-five car miles per day, while an exceptionally well handled eastern road is held down to four or five car miles. On one large and efficiently handled system, composed of twenty operating divisions, the car miles per day are closely checked and reported, and range from about twelve on one division to one hundred and three or more on another. The operating policies of the several divisions are the same; they are all under the same general executive direction. This road makes no pretense of comparing one division with another; but it does compare each division with its own previous best record. Operating officers who have had actual experience in these matters will probably reach the conclusion that the division with the low car mileage is probably a harder job, and is more efficiently handled than the one making greater mileage. This for the reason — if no other — that the very conditions which tend to produce "goutiness" in the "nimble freight car" are those which demand transportation talent of the highest order.

The superintendent of the twelve car miles per day division is, in all probability, the one who has the real fight on his hands. It is not necessary to go into details; his territory may readily be pictured as one with all the complicated problems and innumerable obstacles accompanying the short haul of a switching or terminal division, with the disjointed, distributing and assembling service. Because it is essentially a terminal problem — the real operating problem of the railroads.

Electrical Conductivity of Refractory Materials at High Temperature. To obtain reliable and comparable data on the electrical resistivity at high temperatures of the refractory materials suitable for furnace linings, the Department of the Interior has developed methods and apparatus for making such measurements at the Bureau of Mines Ceramic Experiment Station, Columbus, Ohio. Test pieces for determination of the electrical resistance were prepared from fire clay, kaolin, alundum, diaspore, thoria, silica, zirconia, magnesite, silicon carbide, sillimanite, zirkite and magnesium spinel. Resistance measurements have been run on half of the pieces. Carbon electrodes are employed, measurements being run in an atmosphere of pure nitrogen to a temperature of 1400° C in a gas-tight, platinum-resistance furnace.

Molybdenum in Steel. That molybdenum is one of the most powerful and useful alloying elements in steel has been conclusively demonstrated by experiments conducted by Dr. H. W. Gillett, chief alloy chemist, Department of the Interior at the Ithaca, N. Y., field office of the Bureau of Mines. While the value of molybdenum as a steel alloy is only beginning to be appreciated and its commercial use is still relatively small, the Bureau of Mines considers that it is destined to become widely used as it deserves to be. The United States has abundant supplies of molybdenum which should be available to replace or supplement other metals used as steel alloying elements which at present must be imported.

Pulverized Coal Transported 5,400 Feet Through Five-inch Pipe. It has often been asked, how far can pulverized coal be readily transported with the equipment now available.

This is a question that confronts many engineers when laying plans for a plant in proximity to a mine or where the coal handling facilities are more conveniently located some distance from the plant site.

With a view to determining what is possible in this respect a series of experiments have been conducted, which have resulted in the satisfactory transporting of pulverized coal through a five-inch pipe for a distance of 5,400 feet.

The tests were made on the standard Fuller-Kinyon system consisting essentially of a revolving screw pump which starts the mass in motion and at the discharge end of the pump the mass is aërated by a number of small volume streams of compressed air at moderate pressure. This changes the nature of the material from a compact mass to a semi-fluid in which state it is carried to the point of discharge.

The ability to transport pulverized coal in this manner over long distances will greatly increase the flexibility and adaptability of this fuel where it is necessary to locate the coal preparation plant some distance from the furnaces.

— *Power.*

Cotton Acreage Up in India. Acreage planted to cotton in India this year now is forecast at 17,831,000 acres, as compared with 17,412,000 acres on the same date last year.

— *Textile World*

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EXPLOSIVES
for construction work

ATLAS Ammite SAVES money in three distinct ways: It *cannot* freeze — and that means a saving of thawing costs. Under proper storage conditions, it can be kept indefinitely without deterioration — which means a big saving to many users of explosives. And, last but not least, the blasting itself costs less when the proper grade of Ammite is used — and better work is assured. Let the Atlas Service Man help you determine what grade of Ammite will save the most money for you.

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An Engineer's Duty

No structure is properly designed or built unless it functions safely. There is no more important feature. Therefore it is the engineer's first duty.

Build Safe Walkways

No hazard is so common, causing such large numbers of accidents and heavy compensation claims as "Falls." The Aetna Life Insurance Company paid for injuries to its insured $594,499.31 for 6,395 claims for "Falls on Stairs or Steps"; and $2,718,337.04 for 33,360 "Falls" of all kinds.

USE

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Anti-Slip Treads

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Representatives in all principal cities

Building

To the Future Builders of America's Machinery

Bunting Bushings Help Machines Help Men.

— Baby Bunting

A MACHINE can justify itself only by its performance. It is a worker pure and simple. The machinery builder is either helping do the world's work or hindering it. In every part of every machine quality should be ample. In millions of machines of all kinds Bunting Bushings are worthily meeting the expectations of the machinery builder and user.

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San Francisco
198 Second Street, corner Howard
Douglas 6245

Boston
36 Oliver Street
Main 8488

BUNTING
BUSHING BEARINGS

THE VAIL LIBRARY AT TECHNOLOGY

(*Continued from page 201*)

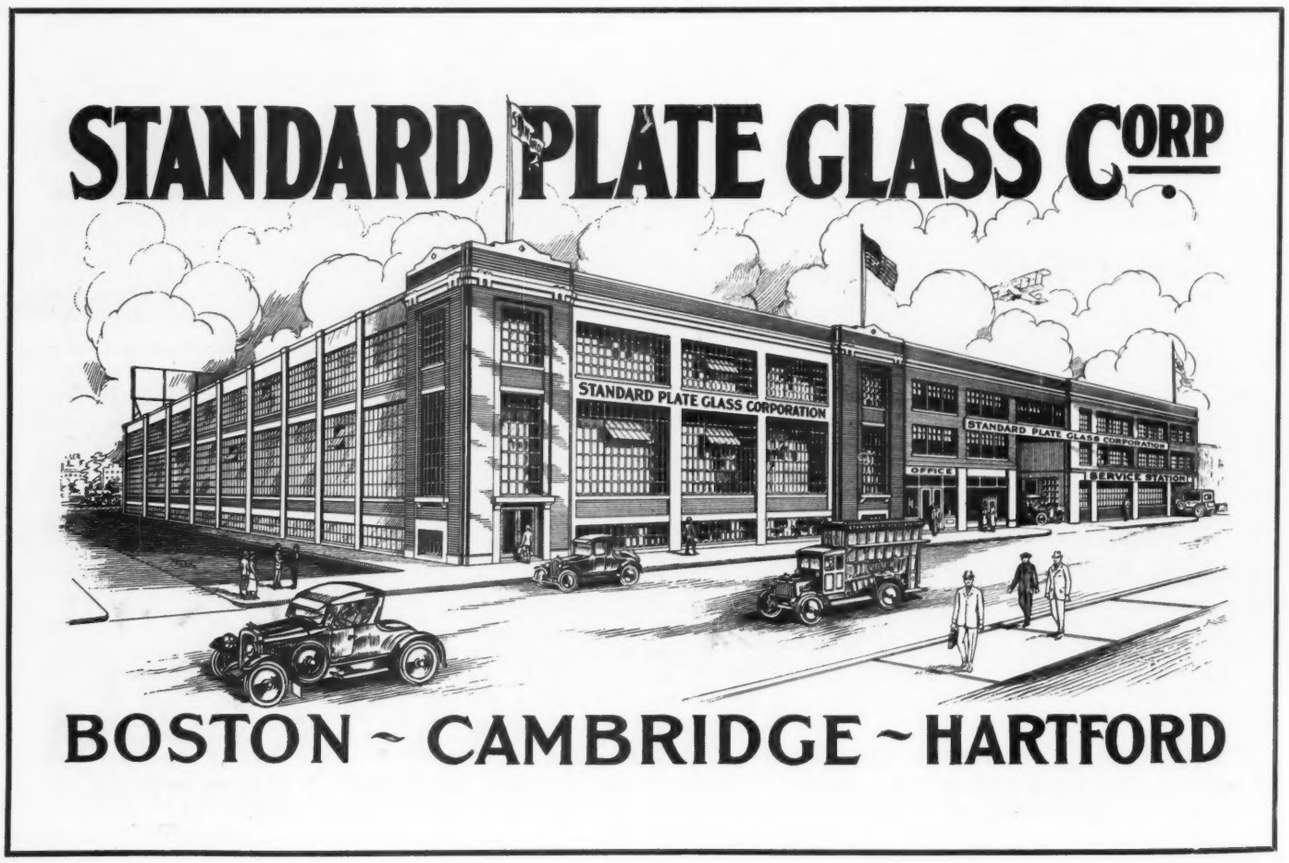
In the meantime the Dering Library was rechristened the Vail Library in honor of the man whose keen insight had so quickly appreciated the unique value of the collection, and the American Telephone and Telegraph Company pledged an annual appropriation for its care and expansion. The Vail Library book-plate consists of a portrait of Mr. Vail, taken during the later years of his presidency of the telephone company, in simple medallion frame resting on a low pedestal upon which are also an open book and a garland of oak leaves; on the face of the pedestal is the brief inscription: "Gift of American Telephone and Telegraph Company to the Massachusetts Institute of Technology, 1912." It was suggested that the words of President Lowell of Harvard in conferring upon Mr. Vail in June, 1915, the degree of LL.D. might appropriately be included in the design of the book-plate: "He has given freely of his wealth and wisdom to the cause of sound education." Though the words were not included in the final design, the quotation may well be contemplated in any consideration of the man and his share in the gift of the Dering Library to Massachusetts Institute of Technology.

During the years of residence on Boylston Street, the M. I. T. Library was made up of many departmental reading rooms, each a separate unit in several of which cataloging and classifying was done by a department assistant. With the move to the Cambridge side of the river came the development of the Central Library with quarters on the fifth floor of Building 10 under the dome. Here in the circular reading room and the two tiers of stacks surrounding it the majority of the old departmental libraries are brought together under one management. The Library staff includes ten members, seven of whom are college graduates (four also professionally trained in library work), and is supplemented by three assistants in the Central Library and one in each of the departmental reading rooms still maintained. The centralization has brought desired results — one cataloging department by which all accessions are uniformly classified and cataloged in a single catalog which therefore shows the total available resources of the Institute Library; a circulation department which administers rules and regulations to the best advantage of all the hundreds of students seeking information; and a reference department which gives professional aid in the solving of collateral and research difficulties.

Such a special library as the Vail Collection — with its thousands of volumes, scores of periodicals and its special librarian — seemed to demand separate quarters in somewhat close connection with the Electrical Engineering Department for whose use it was primarily given, but a few years of such exclusion only proved its disadvantages. The leaders of the department were convinced that incorporation in the main library was the one way in which the Vail Collection could "give freely of its wealth and wisdom" — even as President Lowell had said of its donor — and in the summer of 1922 the library of George Edward Dering was again moved — this time to the stacks of the Central Library. The Vail catalog is to be merged with the main catalog, and the Vail Librarian has her desk in the main reading room. All Vail books are distinguished by a special gold stamp above the usual shelf number on the books themselves, and by special cards in the catalog.

The Vail Library plays an important role in the training of the electrical

(*Continued on page 238*)



What Engineering Owes to the Imagination

From An Argument Over Watches Came KDKA

BACK in the days when wireless was just beginning to spread, Frank Conrad (now Assistant Chief Engineer of the Westinghouse Electric & Manufacturing Company) and another official, happened to compare watches, to see if it was time to go back to work. Their watches differed.

Unable to convince his friend that his watch was right, Mr. Conrad suddenly remembered that the naval station at Arlington, Va., had just inaugurated a system for sending out daily time signals by radio. Just the thing to prove his point!

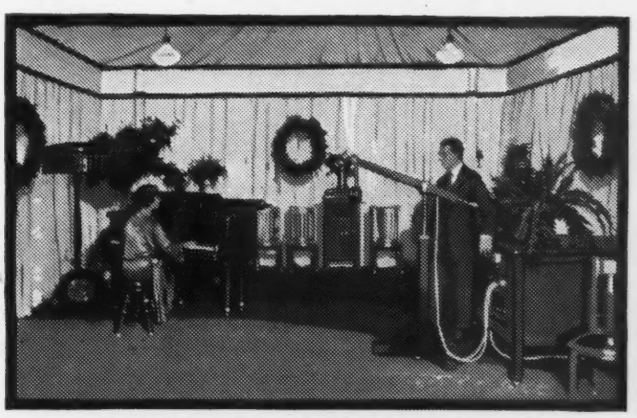
So he built a simple set of receiving apparatus, erected an aerial, and—you can imagine what happened! He was badly bitten by the radio bug. After proving to his satisfaction the accuracy of his watch, he started experimenting with the transmission of music by radio, with good success.

He began sending out phonograph music from his home, and attracted the attention of some of the big department stores, that had installed radio departments. They in turn, started advertising Mr. Conrad's "musical evenings."

Then, one day, upon arriving at his desk, he was summoned to the office of Harry Phillips Davis, Vice President of the company.

"Frank," said Mr. Davis, "I'm going to close your radio station." His attention had been attracted the night before to a simple note in a full-page advertisement, which read, "Mr. Conrad will send out phonograph music this evening."

You know the rest. In November, 1920, "KDKA" was formally opened to send out election returns. It had received the first license issued by Uncle Sam. Today over 500 broadcasting stations entertain and educate millions of people each night, a wonderful result from so insignificant an argument as one over watches.



Broadcasting Studio at Station KDKA, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa

Westinghouse

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VAIL LIBRARY

(*Continued from page 236*)

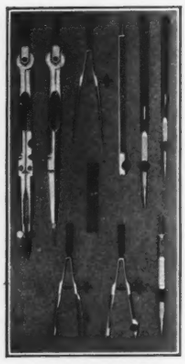
students at Tech. The Federated American Engineering Societies have urged upon all engineering colleges "an increased attention to the social aspects of engineering activities and a broadening of technical training in every way possible to develop in engineering students the spirit of and capacity for active leadership, not only in industry, but in public affairs." For the carrying out of this high ideal the Vail Library offers exceptional facilities. Its uses — if they can be limited — classify under four comprehensive headings: 1, special information on research problems; 2, general technical knowledge; 3, professional knowledge; and 4, inspirational recreation.

Uses 1 and 2 are the natural emanations of a specialized technical collection, wide in scope, properly administered and wisely developed. The Vail Librarian gives both class and individual instruction in methods of attacking reference problems; in using technical indexes, abstracts and bibliographies to best advantage; and in making original bibliographies. With the aid of students and department staff a union bibliography on cards is being made of all "classic" references and all current references which intimate a tendency to become "classic" in the various fields of electrical engineering. This will eliminate repetition of search for desired information and minimize the time needed to accumulate the material for study at a given time.

According to a Library regulation Seniors and Graduate students may browse in the stack alcoves and gain a personal appreciation of the values of the Vail Collection — a visual knowledge at least of the vast amount of literature outside of the few textbooks handled in the immediate preparation of class work. They learn the names of authors and publishers prominent in electrical literature — names in many languages from many parts of the world, for the Collection is rich in foreign literature. (The London bookseller was faithful to Mr. Dering's injunction and gathered his electrical books from far and near.)

Just the sight of so much interesting material inspires a student to "brush

(*Continued on page 240*)



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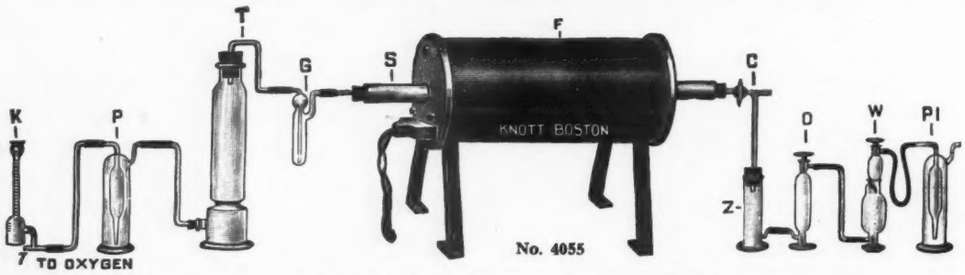

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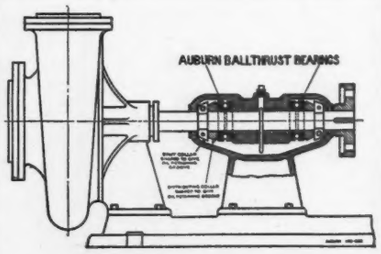

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VAIL LIBRARY

(*Continued from page 238*)

up" on that knowledge of French and German, Spanish and Italian, once so ready in a moment of need, but so quickly forgotten without an impulse to "keep up." It is much more interesting to read Volta, Ampère, or Galvani in his native tongue than in translation. Then, too, there are odd little pamphlets by perhaps unknown writers but full of a wealth of information. Of the seven thousand pamphlets listed when the collection was purchased many were sufficiently valuable to warrant binding; others, still in pamphlet form, are classified and shelved in available boxes. New books and pamphlets are being added constantly and Mr. Dering's wish that the Collection should be universal is still being fulfilled. Current literature of importance to the electrical world as a whole, or to any remote part of it, is sought and obtained whenever possible. For example, recent accessions include:

Laspiere. Les grands reseaux de transport à très haut tension.

Fleming. Electrons, electric waves and wireless telegraphy.

Nesper. Radio-schnell-telegraphie.

(Subscription to) Commonwealth Engineer — Australia.

Baum. Atlas of U. S. A. electric power industry.

Lombardi. Corso tecnico-pratico di elettrotecnica.

Koerts. De storingsvrijheid van ontvangers voor dreadlooze telegrafie.

Of the nine hundred periodicals which are regularly received in the Central Library between one hundred fifty and two hundred are either exclusively electrical or of definite interest to electrical engineers. All of these are reviewed by the Vail Librarian, notations made for the Union bibliography and references to articles of immediate current value posted on the department bulletin boards. The universality of the Collection is again emphasized in these periodical sets. Australia, Japan, Denmark, Argentine Republic are represented, as well as England, France, Italy, Spain, Belgium and Germany. A special project on foot at present is the expansion of the Radio section to include current periodicals of all countries interested in this new phase of electrical communication. Decisions are being made from a list of some seventy-five radio periodicals issued by thirteen different

(*Continued on page 242*)

E. C. M. A.

The Engineering College Magazines Associated

An organization of the eighteen leading college technical journals of the country; it was founded for the purpose of raising the standards of college engineering journals and in this way serving to better advantage the alumni and undergraduate engineers, and the advertisers desiring to reach this field.

There are *twenty-five thousand* subscribers eager to know all about the latest developments in commercial engineering to whom no better or more pleasing approach can be made than in their own college magazine. There are *fifteen thousand* student subscribers anxious to know and understand the concerns they will be affiliated with when they graduate.

THE TECH ENGINEERING NEWS, as founder of this group, stands ready to coöperate with any engineering concern desirous of reaching the most fertile field of potential users of engineering equipment ever brought together for the service of the advertiser.

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Photograph of 470 John Hancock Policies written on the lives of students of the 1923 Graduating Class of the Massachusetts Institute of Technology

THESE policies represent $125,000 in endowment insurance payable to M. I. T. at the 25th Reunion of the Class of 1923. The members have insured as individuals and will pay their own premiums as a visible evidence of their loyalty to the Institute. This picture is reproduced in a Tech publication for several reasons:

The M. I. T. Alumni Association naturally hopes that the 1923 example will be followed by subsequent graduating classes—by individual undergraduates who are able and willing to do more individually—by graduates who may take simultaneous action individually or in groups, thus assisting in providing endowments for future needs in a large way—and by individual alumni who will make provision for general funds or for promotion of some special interest.

The Massachusetts Institute of Technology was founded in April, 1861, just a year before the John Hancock Mutual Life Insurance Company was chartered in the Commonwealth of Massachusetts. Both of these institutions have developed in Boston, side by side, and both have become leaders in their respective spheres.

The John Hancock Mutual Life Insurance Company desires to serve Technology to the best of its ability. Information in regard to Technology endowments can be secured from any agent of the John Hancock Mutual Life Insurance Company or by addressing the Home Office, 197 Clarendon Street, Boston, Massachusetts.

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Now insuring One Billion Seven Hundred Million dollars in policies on 3,250,000 lives

VAIL LIBRARY AT TECHNOLOGY

(*Continued from page 240*)

countries. Students and faculty too who have helped IXM in its successful transatlantic communication want first-hand information from other parts of the world.

Books, periodicals, pamphlets — references, bibliographies — all these are vital elements of library mechanism, but an element more vital than any of these in the motive force of the Vail Library is the power of humanity. Just as the prime mover of a central electric station generates so many horsepower of energy, so does the Vail Library strive to generate human power. In an editorial entitled "The Future of Engineering Education" (*Engineering Education*, January, 1923) F. G. Higbee, Vice President of the Society for the Promotion of Engineering Education, said, "Engineering education has failed to give the breadth of training needed by the engineer of today and demanded of the engineer of tomorrow. His technical equipment is quite generally regarded as adequate, but the background needed to make this technically trained engineer most useful to society is lacking," and President Morgan of Antioch College, writing at about the same time, said, "Even for the technical engineer relations with people are more fundamental than relations with things . . ." Through the Vail Library the student builds this human substructure of his profession — practical information to strengthen his technical knowledge. He gains knowledge of other men in the profession; he becomes familiar with authorities and their specialities — Dr. Millikan and the electron, Dr. Langmuir and the vacuum tube, to mention only two names; and he learns what new projects are on foot — in some of which he may participate — and what are the live topics up for discussion in that professional world which he is soon to enter. The literature of the electrical societies — monthly journals or bulletins, and yearly transactions — hold a place of importance subordinate only to the textbooks in the young engineer's training. When he first attempts under advice to follow this source of information closely and carefully, he is perhaps bewildered by the immensity of material offered and its sometimes extreme technicality. Later he goes to the same source for information on a special topic, "The effect of transient voltages on dielectrics," for example; he finds that he has perhaps two chief references, one to an article published ten years previously, the second to one published in an issue of the current year; the author of the first article is an authority of prominence, the author of the second is — he looks twice to make sure — a man who studied at the Institute for his doctorate only a few years before. The student's enthusiasm is immediately aroused — the human power is distributing its energy. A year later the same student is doing research for his thesis; he needs the earliest data possible on the development of a fundamental theory; he finds in the book stacks a volume written by an English scientist nearly a century before. It occurs to him that the article in the current periodical by the Massachusetts Institute of Technology graduate student may be incorporated in just such another volume for student inspiration a hundred years hence.

Electrical literature of the periodical type is being made rapidly and in such abundance that judicious discrimination has to be exercised in separating the valuable from the ephemeral. All Society publications are of unquestionable value, and the majority of the electrical magazines contain current topic articles of lasting merit. Many books of the future are running serially in periodicals. Then there is that large class of present-day literature known variously as "House Organs," "Trade Journals," "Company Magazines." Here special discrimination must be used in the choice of those upon which it is wise to spend much time, but this very live source of information must not be neglected. According to the National Electric Light Association Bulletin of March, 1922, "the cur-

(*Continued on page 244*)

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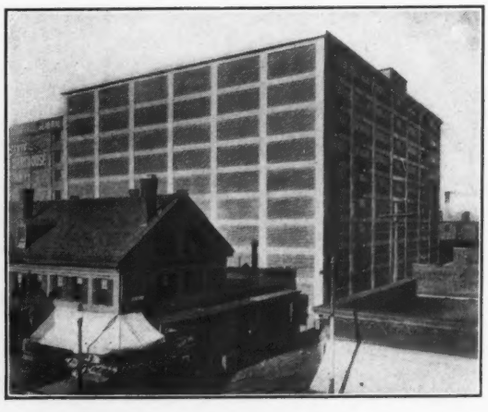
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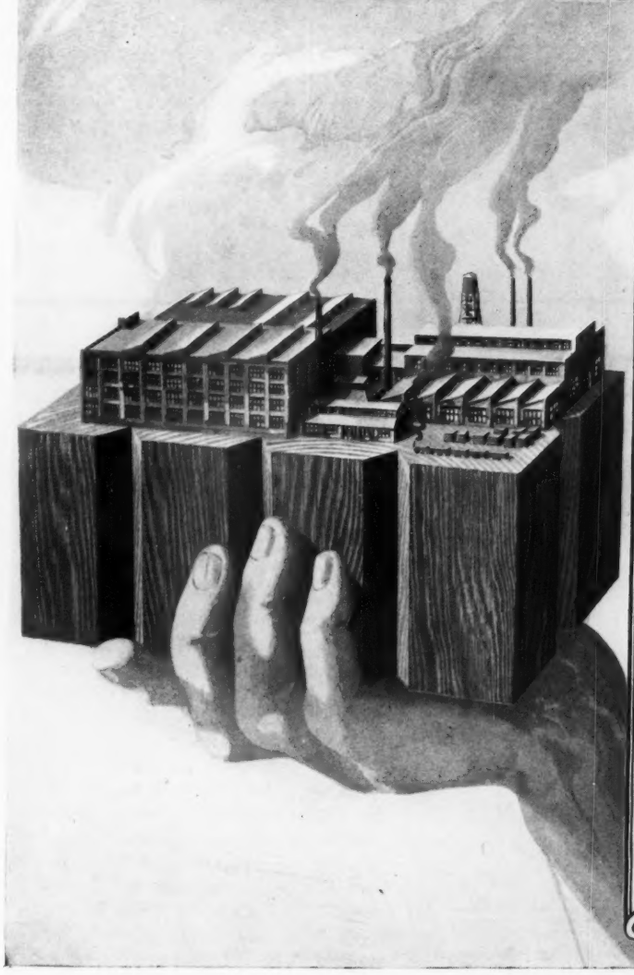

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Let our Kreolite factory engineers study your factory floor needs, *gratis.* Write for booklet.

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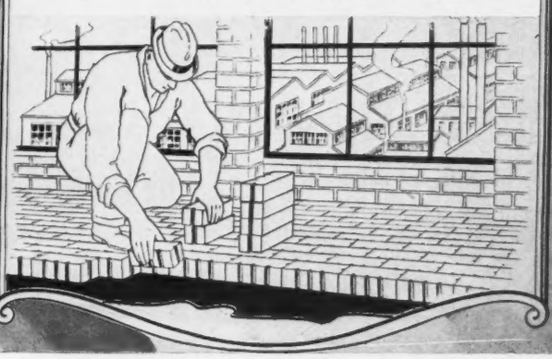

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WOOD BLOCK FLOORS

THE VAIL LIBRARY AT TECHNOLOGY

(*Continued from page 242*)

rently issued house organs of the member companies of the National Electric Light Association number more than one hundred, and their combined circulation is more than three fourths of a million." In this number are included such periodicals as the *Bell Technical Journal, Stone & Webster Journal, Electric Journal(Westinghouse)*, and *General Electric Review*, all of which, because of their technical excellence, rank higher than the average house organ, and yet they are magazines issued by companies at periodical intervals. The same may be said of such foreign publications as the *Brown-Boveri Review, Siemens Zeitschrift, English Electric Journal* and *Bulletin Oerlikon* which, by the way, are not included in the above National Electric Light Association enumeration. With all of these company magazines, and many more, the Tech Electrical Engineering student becomes familiar in the Library. With other more distinctly company organs — *Edison Round Table, Schenectady Works News, Lynn Works News, Telephone Topics, Long Lines* — he becomes more familiar in his months of actual work with the companies which publish these magazines for their employees, for the Electrical Engineering Department now offers coöperative options with five major companies — General Electric Company, American Telephone & Telegraph Company, Boston Elevated Railway, Edison Electric Illuminating Company and Stone & Webster. This coöperative work gives the student a new relation with that human power so necessary to his profession. He comes in contact with the hundreds of workers who are making possible the wonderful development of the electrical world — he is one of them — and he realizes the responsibility of the leadership that may be his if he so deserves. He goes back to the Institute with a new vigor and a new respect for the little house organ on the library shelves. He begins to be interested in trade catalogs and bulletins, published primarily for commercial purposes, but full of worthwhile information for the student and engineer. A complete collection of such material would be beyond bounds, but the Vail Library keeps a file of current trade literature for ready reference.

Emphasis has been put on this third use of the Vail Library — professional information — because of its vitalizing influence, but the use which must have been uppermost in Mr. Dering's mind while the collection was culminating was that numbered 4 — inspirational recreation. The imprint dates of the thirty-three thousand volumes in the Vail Collection range from 1508 through the four centuries to 1923, and every item in the collection has some bearing on electricity. The mere contemplation of such a wealth of literary material is in itself an inspiration. The Collection is at once technical and historical, for the development of every phase of modern electrical engineering can be traced in original sources. In the course of a talk to the Sophomores last spring a visiting professor from a neighboring engineering school outlined the chronology of electrical development from 1750 to the present era, itemizing the main inventions with the names of their inventors. Every name is represented in the Vail catalog by either original professional writings, or biographical literature, or both. It is interesting to note that the research workers of the early nineteenth century were much more voluminous writers of their theories and discoveries than

(*Continued on page 246*

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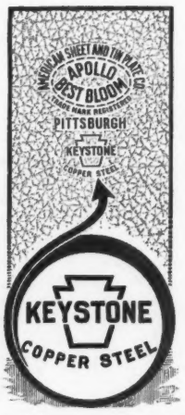

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INDUSTRIAL LIGHTING CODES.

In order to protect workers from accidents and eye sight damage, no less than five states, New York, New Jersey, Pennsylvania, Wisconsin and Oregon have now in force lighting codes for industrial establishments. Other states are now considering the adoption of an industrial lighting code, and it seems only a question of time when all the states will adopt such a code.

Proper lighting of work places is not only of great importance to the operators working therein, directly affecting their safety and eyesight, but it is a factor of equal importance to the employer, as quality and quantity of output are deciding factors of profit or loss in the operation of the plant.

The introduction to the Wisconsin code reads as follows: "Insufficient and improperly applied illumination is a prolific cause of industrial accidents. In the past few years numerous investigators, studying the cause of accidents, have found that the accident rate in plants with poor lighting is higher than similar plants which are well illuminated. Factories which have installed approved lighting have experienced reductions in their accidents which are very gratifying.

"Of even greater importance, poor lighting impairs vision. Because diminution of eyesight from this cause is gradual, it may take the individual years to become aware of it.

"This makes it all the more important to guard against the insidious effects of dim illumination, of glaring light sources shining in the eyes, of flickering light, of sharp shadows, of glare reflected from polished parts of work. To conserve the eyesight of the working class is a distinct economic gain to the state, but regardless of that, humanitarian considerations demand it.

"Finally, inadequate illumination decreases the production of the industries of the state, and to that extent, the wealth of its people. Factory managers who have installed improved illumination, are unanimous in the conviction that better lighting increases production and decreases spoilage."

The Wisconsin Commission has adopted a rule to the effect that, "diffusive or refractive window glass shall be used for the purpose of improving day light conditions or for the avoidance of eye strain, wherever the location of the work is such that the worker must face large window areas, through which excessively bright light may at times enter the building."

A glass is now available which meets the above requirements. It properly diffuses the light and prevents sun glare passing into the building and is known as Factrolite.

Engineers of to-day are making a thorough study of illumination, so that they may be able to plan and lay out industrial plants, to scientifically increase their efficiency to as near the maximum as possible. This accomplished the engineer is not only doing something worth while for his employer, but is doing quite as much for himself by coming into prominence with modern ideas.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,
220 Fifth Avenue,
St. Louis. New York. Chicago.

VAIL LIBRARY

(*Continued from page 244*)

those of the twentieth century. Volta is represented in the Collection by thirteen volumes of original exposition, Faraday by thirty-one, while Alexander Graham Bell, Thomas A. Edison and Marconi are represented by two each.

Then there are the "rare books." A rare book is not always rated by its pecuniary value in the book dealer's realm. A collector who has set his heart on a Shakespeare folio will scorn a first edition of Gilbert's "De Magnete" — not so the scientist and student of electricity. After eighteen years of investigation and experiment William Gilbert wrote this remarkable work in the history of scientific discovery, "De magnete, magneticisque; corporibus et magno magnete tellure, sex libris comprehensus," and Petrus Short published it in London in 1600. Its 240 twenty-eight-centimeter pages are bound in vellum and there are 95 illustrations and several plates. As the title indicates the volume is devoted mainly to magnetic theory, but Book 2 contains Gilbert's original electrical work.

Sixteen hundred and thirteen is the date imprinted on a smaller 157-page volume written by Mark Ridlye and published in London by Nicholas Okes. Its title is "A Short Treatise of Magneticall Bodies and Motions," and it is based on Gilbert's "De Magnete." The tract was attacked by Archdeacon Barlowe in the first of electrical controversies, the plaintiff declaring that the defendant had stolen his manuscript and embodied its contents in this treatise.

An Italian imprint, "Ferrarie apud Franciscum Succium superiorum permissu 1629" is found on the title page of another rarity, "Philosophia magnetica in qua magnetis natura penitus explicatur . . ." by Nicolao Cabeo. This first edition of the work of the famous Italian Jesuit is a folio of 412 pages, illustrated, and is bound in French morocco. It discusses Gilbert's discoveries and often attacks his theories on terrestrial magnetism. Cabeo maps out the magnetic field with iron filings; he gives diagrams of the magnetic telegraph; and is the first to recognize electrical repulsion.

These early seventeenth century books are among the better known treasures in electrical literature, but the sixteenth and eighteenth centuries are represented also in the Vail Collection with quaint volumes of interest to the scientific scholar. There are early treatises on the compass such as the "De ventis et navigatione . . . Venetiis Montisferrati, 1546 18 p. il. 20 cm," written by M. A. Blondus. There is the "De magnete" of Peregrinus — "Peregrinus, Petrus De magnete, seu rota perpetui motus . . . Augsburg in Suevis, 1558" — from which Taisnier incorporated much without permission in his "Opusculum perpetua memoria dignissimum, de natura magnetis et eius effectibus . . . Coloniae apud Joannem Birchmannum 1562." There is the work of Aepinus, a pioneer investigator who submitted electrical phenomena to mathematical analysis, who believed in the affinity of electricity and magnetism, and who adopted, with modifications of his own, Franklin's one-fluid theory, "Tentamen theoriae electricitatis et magnetisimi . . . Petropoli Typis Academiae Scientiarum, 1759." The oldest book in the Collection is an anonymous volume bound in thick boards which show the marks of metal clasps, entitled "Margarita philosophica toti philosophie rationalis . . ." and dated 1508.

Of such varied content is the Vail Collection. Its value cannot be measured in words. George Edward Dering expected to browse among its volumes when he had become wearied of experiment and invention. Instead, hundreds of young men at the beginning of their professional career are gaining from it a realization of the vastness of electrical literature, and the value of the printed word in close connection with the research experiment. They are learning a new love for books — a love very close to reverence. The written words of the electrical pioneer of yesterday, offered with those of the engineer of today, are an inspiration to the leader of tomorrow.

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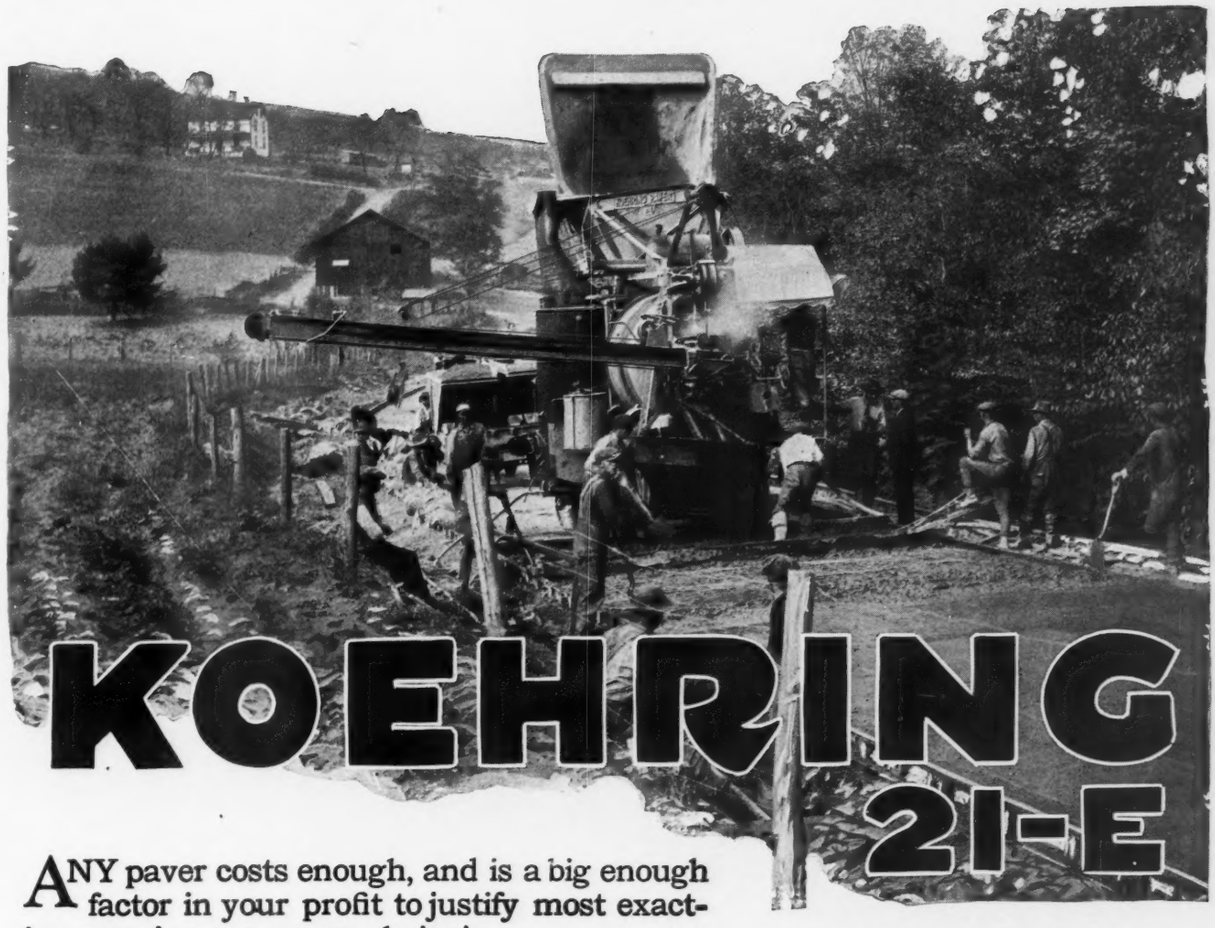

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You ought to know all about the Koehring 21-E Paver—not merely the general facts, but the details of construction—because this paver is the product of mature Koehring leadership experience in the paver field, and of the outstanding, inflexible Koehring policy of "Heavy Duty" construction. Beyond question — in its liberal drum dimensions, its day-by-day, season-by-season yardage ability, its high speed operation and "Heavy Duty" construction — this paver is the standard by which to judge paver values. It is worth your while to be thoroughly informed. You do yourself a truly valuable service by writing for the Koehring Paver Bulletin P.

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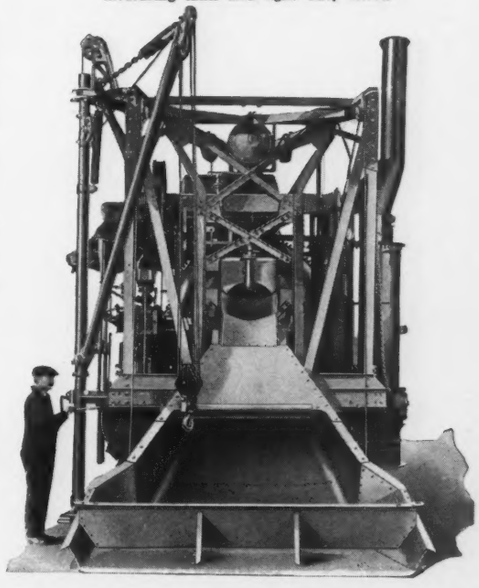
Heavy Duty Construction Mixers: 10, 14, 21, 28 cu. ft. mixed concrete.

Pavers: 7, 10, 14, 21, 32 cu. ft. mixed concrete.

Dandie Light Mixer: 4 and 7 cu. ft. mixed concrete. May be equipped with power skip or low charging platform. Water measuring tank and light duty hoist.



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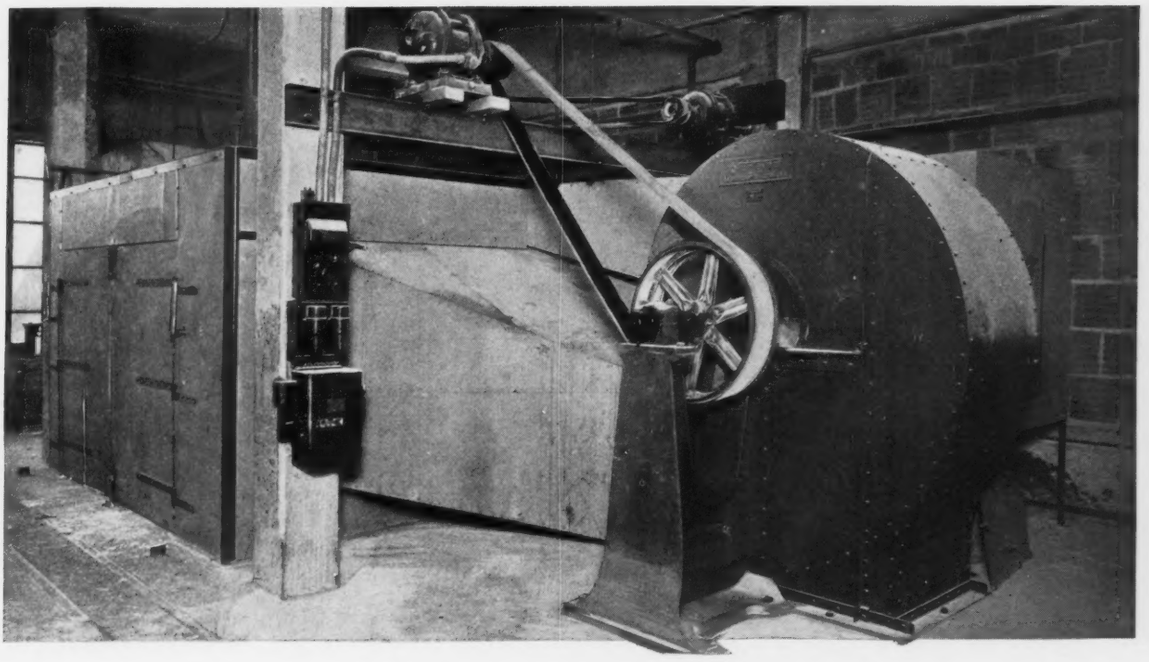

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ANTOINE LAURENT LAVOISIER
1743-1794

Born in Paris, son of a wealthy tradesman. As a student won a prize for an essay on lighting the streets of Paris. Held various Government posts. A martyr of the Reign of Terror. Founder of modern chemistry.

They couldn't destroy the work he did

"The Republic has no need for savants," sneered a tool of Robespierre as he sent Lavoisier, founder of modern chemistry, to the guillotine. A century later the French Government collected all the scientific studies of this great citizen of Paris and published them, that the record of his researches might be preserved for all time.

Lavoisier showed the errors of the theory of phlogiston—that hypothetical, material substance which was believed to be an element of all combustible compounds and to produce fire when liberated. He proved fire to be the union of other elements with a gas which he named oxygen.

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